

## Snailfishes (Pisces: Liparidae) of Australia, Including Descriptions of Thirty New Species

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**ABSTRACT.** Examination of all available liparid specimens collected in Australian waters revealed more than 30 new species in three genera: *Careproctus* Krøyer, *Pseudnos* Barnard, and *Paraliparis* Collett. This is the first published description of liparids from Australia. The new species include *Careproctus paxtoni* n.sp., *Pseudnos balushkini* n.sp., *Ps. nataliae* n.sp., *Ps. whitleyi* n.sp., *Paraliparis anthracinus* n.sp., *P. ater* n.sp., *P. atrolabiatus* n.sp., *P. auriculatus* n.sp., *P. australiensis* n.sp., *P. avellaneus* n.sp., *P. badius* n.sp., *P. brunneocaudatus* n.sp., *P. brunneus* n.sp., *P. coracinus* n.sp., *P. costatus* n.sp., *P. csiroi* n.sp., *P. delphis* n.sp., *P. dewitti* n.sp., *P. eastmani* n.sp., *P. gomoni* n.sp., *P. hobarti* n.sp., *P. impariporus* n.sp., *P. infeliciter* n.sp., *P. labiatus* n.sp., *P. lasti* n.sp., *P. obtusirostris* n.sp., *P. piceus* n.sp., *P. plagiostomus* n.sp., *P. retrodorsalis* n.sp., *P. tasmaniensis* n.sp., and four more unnamed taxa. All are endemic to Australia. We discuss and describe new characters, describe the new species and provide keys for their identification. The described *Paraliparis* species are morphologically very similar to one another, and form a group that is clearly distinct from the Antarctic species of the genus, suggesting that the two groups are not closely related and that neither is derived from the other. Two of the unnamed taxa constitute the second record of liparids from the Indian Ocean.

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The family Liparidae was long considered to be almost completely confined to the Northern Hemisphere (Burke, 1930), with only a few poorly known species described from the South Atlantic, the southern tip of South America, and the Antarctic. In fact, liparids seem to occur worldwide in marine environments where temperatures are low enough. In equatorial areas, they exhibit tropical submergence and occur in cold waters at great depths, but (with one exception, *Liparis fishelsoni* Smith, 1967) not in shallower, warmer

waters. Within the last ten years, it has become apparent that the Southern Hemisphere has an extensive liparid fauna composed entirely of endemic species. The Southern Ocean is particularly rich, having well over 100 species representing seven genera (Andriashev, 1986; Andriashev, 1993; Stein & Andriashev, 1990; Andriashev & Stein, 1998; Duhamel, 1992; Stein & Tompkins, 1989). There is also a Chilean group of liparids, including a morphologically notable endemic genus, *Eknomoliparis* (Stein *et al.*, 1991).

Given this “explosion” of new taxa from a poorly known region, it is not surprising that other temperate southern waters also include diverse liparid species.

Recent interest in Australian deep-water fisheries has led to collections in previously unsampled areas and depths (Koslow *et al.*, 1994; May & Blaber, 1989). Although liparids have been reported from Australian waters (Koslow *et al.*, 1994; Williams, Last, Gomon, & Paxton, 1996) they were tentatively identified only to family or genus, and no species had been described from Australian waters. Examination of all available material revealed more than 30 new species in three genera of which we describe 30: *Careproctus* Krøyer, 1862 (1 new species); *Pseudnos* Barnard, 1927 (3 new species); and *Paraliparis* Collett, 1878 (26 new species) (Table 1). In this paper we describe all extant material, name these species where possible, and provide keys for their identification. In addition, we describe, but owing to their poor condition, do not name, three additional species of *Paraliparis* and one of *Pseudnos*.

Because of the diversity and distribution of the liparids described here, we provide a short description of the south-eastern Australian continental slope and its environment. With two exceptions (the specimens collected off northwest

Australia), all our specimens were collected from about 130°E in the Great Australian Bight, western and southwestern Tasmania, the eastern end of Bass Strait, and off Victoria and New South Wales as far north as about 33°S (Fig. 1). Although the surface currents and near shore (shelf) benthic environment of the region are fairly well known, until recently those of greater depths were not (Bunt, 1987). To the west, the gently sloping (1:600) heavily sedimented Cedura Plateau extends between about 130–134°. Between it and Tasmania (from 134–141°E) the slope is very steep, cut by many deep canyons with vertical relief up to 2000 m (Williams & Corliss, 1982). Further east and south, the continental shelf on both sides of Tasmania is very narrow and steep so that deep water occurs relatively close to shore (Exon *et al.*, 1995). Some very large canyons occur on the eastern side of Bass Strait and on the southern Victoria coast (Conolly, 1968). Sediments inshore are primarily CaCO<sub>3</sub>/SiO<sub>2</sub>; farther offshore on the upper slope and below, they are CaCO<sub>3</sub> (Williams & Corliss, 1982).

Oceanographically, the southern coast of Australia as far east as 147°E (the southern tip of Tasmania) is considered to be part of the Indian Ocean (Rao & Griffiths, 1998); waters further to the east are part of the western Pacific.

**Table 1.** List of new species collected, registration (including type status: H—holotype, P—paratype, sex, museum, and specimen number); standard length (SL, mm); collection location; depth (m); and date of capture.

| new species collected                           | registration                  | SL    | collection location                        | depth     | capture date |
|---|-------------------------------|-------|--|-----------|--------------|
| <i>Careproctus paxtoni</i> n.sp.                | H ♀ AMS I29737-003            | 134   | 35°29'S 150°55'E                           | 1116–1134 | 31 Aug 1989  |
| <i>Careproctus paxtoni</i> n.sp.                | P ♀ AMS I29802-001            | 144   | 35°28.5'S 150°53.5'E                       | 1061–1088 | 30 May 1989  |
| <i>Pseudnos balushkini</i> n.sp.                | H ♂ AMS I24860-002            | 84    | 34°48.5'S 151°15.5'E                       | 914–960   | 4 Oct 1984   |
| <i>Pseudnos balushkini</i> n.sp.                | P ♂ AMS I24059-018            | 82    | 33°32'S 152°09'E                           | 942–978   | 23 Aug 1983  |
| <i>Pseudnos nataliae</i> n.sp.                  | H ♂ CSIRO H2636-04            | 98.5  | 42°16'S 144°39'E                           | 1100–1120 | 18 Mar 1989  |
| <i>Pseudnos whitleyi</i> n.sp.                  | H ♂ CSIRO H1335-02            | 91.2  | 41°18.4'S 144°05'E                         | 900–920   | 14 May 1986  |
| <i>Paraliparis anthracinus</i> n.sp.            | H ♀ CSIRO H1576-02            | 133   | 41°46.4'S 144°24.4'E                       | 1024–1080 | 14 May 1986  |
| <i>Paraliparis ater</i> n.sp.                   | H ♀ CSIRO H749-04             | 124   | 41°45.8'S 144°24.8'E                       | 1000–992  | 16 May 1986  |
| <i>Paraliparis atrolabiatus</i> n.sp.           | H ♂ CSIRO H550-11             | 114   | 42°20.45'S 144°40.4'E                      | 1120–1220 | 17 May 1986  |
| <i>Paraliparis auriculatus</i> n.sp.            | H ♀ CSIRO H749-06             | 131   | 41°45.8'S 144°24.8'E                       | 1000–992  | 16 May 1986  |
| <i>Paraliparis australiensis</i> n.sp.          | H ♀ NMV A21497                | 164   | 37°01.09'S 137°25.44'E                     | 1090–1160 | 24 Jan 1988  |
| <i>Paraliparis avellaneus</i> n.sp.             | H ♂ NMV A5873                 | 132   | 37°01.09'S 137°25.44'E                     | 1090–1160 | 24 Jan 1988  |
| <i>Paraliparis badius</i> n.sp.                 | H <sup>a</sup> CSIRO T1981-01 | 82    | off Tasmania                               | unknown   | 20 Oct 1984  |
| <i>Paraliparis brunneocaudatus</i> n.sp.        | H ♂ CSIRO T1980-01            | 127   | W coast of Tasmania                        | unknown   | Apr 1984     |
| <i>Paraliparis brunneus</i> n.sp.               | H ♀ CSIRO H749-05             | 151   | 41°45.8'S 144°24.8'E                       | 1000–992  | 16 May 1986  |
| <i>Paraliparis coracinus</i> n.sp.              | H ♀ CSIRO H1935-02            | 70+   | 37°34.53'S 138°57.00'E                     | 1205–1175 | 1 Feb 1989   |
| <i>Paraliparis costatus</i> n.sp.               | H ♂ CSIRO H561-02             | 204   | 41°51.4'S 144°23.8'E                       | 1366–1370 | 16 May 1986  |
| <i>Paraliparis costatus</i> n.sp.               | P ♀ CSIRO H1378-01            | 235   | 42°12'S 144°38'E                           | 1042–1080 | 21 Apr 1988  |
| <i>Paraliparis csiroi</i> n.sp.                 | H ♀ NMV A5874                 | 163   | 38°37.58'S 141°01.12'E                     | 1080–1110 | 8 Feb 1988   |
| <i>Paraliparis delphis</i> n.sp.                | H ♂ CSIRO H749-03             | 127   | 41°45.8'S 144°24.8'E                       | 1000–992  | 16 May 1986  |
| <i>Paraliparis dewitti</i> n.sp.                | H ♀ CSIRO T889-02             | 192   | 34°26.5'S 132°04'E                         | 1175–1118 | 14 Nov 1984  |
| <i>Paraliparis eastmani</i> n.sp.               | H ♂ AMS I28900-003            | 183   | 33°29.5'S 152°12.5'E                       | 1035–1070 | 1 Sep 1988   |
| <i>Paraliparis gomoni</i> n.sp.                 | H ♂ NMV A7124                 | 110   | 39°00.92'S 148°43.71'E                     | 1140–1160 | 13 May 1988  |
| <i>Paraliparis hobarti</i> n.sp.                | H ♀ CSIRO H3170-01            | 124   | continental slope of Tasmania <sup>b</sup> |           |              |
| <i>Paraliparis impariporus</i> n.sp.            | H ♀ CSIRO H3168-01            | 162   | 41°51.97'S 144°27.16'E                     | 1040–1050 | 14 Mar 1989  |
| <i>Paraliparis infeliciter</i> n.sp.            | H ♀ CSIRO H3169-01            | 153   | 37°37.9'S 139°00.60'E                      | 1070–1090 | 30 Jan 1988  |
| <i>Paraliparis labiatus</i> n.sp.               | H ♀ CSIRO H749-02             | 150   | 41°45.8'S 144°24.8'E                       | 1000–992  | 16 May 1986  |
| <i>Paraliparis lasti</i> n.sp.                  | H ♂ CSIRO T982-02             | 185   | 33°45.5'S 129°37.5'E                       | 1152–1000 | 5 Jun 1983   |
| <i>Paraliparis obtusirostris</i> n.sp.          | H ♀ NMV A7123                 | 137   | 38°57.09'S 148°41.95'E                     | 1270–1290 | 13 May 1988  |
| <i>Paraliparis piceus</i> n.sp.                 | H ♂ CSIRO H805-04             | 149   | 41°51.25'S 144°23.1'E                      | 1384–1416 | 18 May 1986  |
| <i>Paraliparis plagiostomus</i> n.sp.           | H ♂ CSIRO T488-02             | 137   | 42°19.5'S 144°42'E                         | 993–987   | 9 Jul 1983   |
| <i>Paraliparis retrodorsalis</i> n.sp.          | H ♀ CSIRO H1935-01            | 145   | 37°34.53'S 138°57.00'E                     | 1205–1175 | 1 Feb 1989   |
| <i>Paraliparis tasmaniensis</i> n.sp.           | H ♀ CSIRO H2679-02            | 201   | 40°26.64'S 143°18.36'E                     | 1000–1100 | 6 Mar 1989   |
| <i>Paraliparis</i> sp. 1                        | ♀ CSIRO H549-05               | 134+  | 41°50.4'S 144°23.45'E                      | 1328–1288 | 25 May 1986  |
| <i>Paraliparis</i> sp. 2                        | ♂ CSIRO H555-04               | 131   | 42°20.6'S 144°37.25'E                      | 1376–1404 | 17 May 1986  |
| <i>Paraliparis</i> sp. (cf. <i>copei</i> group) | ♂ AMS I22809-036              | c.178 | 18°40'S 116°42'E                           | 584–592   | 4 Apr 1982   |
| <i>Paraliparis</i> sp. (cf. <i>copei</i> group) | ♂ AMS I22813-018              | 154+  | 18°32'S 116°50'E                           | 658–660   | 6 Apr 1986   |

<sup>a</sup> juvenile, sex unknown    <sup>b</sup> no other data

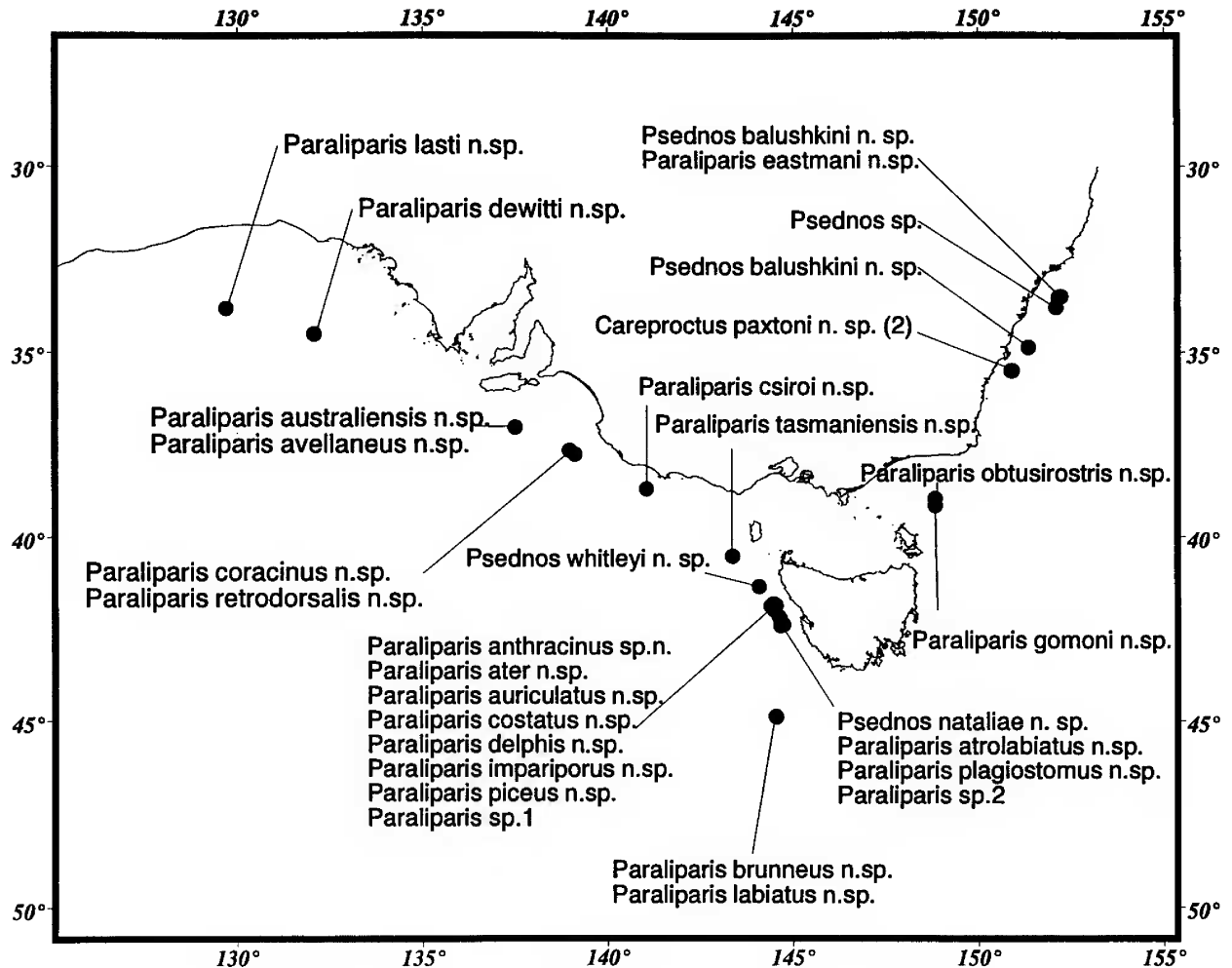


Figure 1. Chart of southeastern Australia, showing collection locations of the new species where known.

Throughout both areas, slope waters are generally derived or at least strongly influenced by the cold Antarctic Intermediate Water (Tchernia, 1980). Temperatures on the southeastern coast of Victoria range from 7.0° at 720 m to 3.6° at almost 1300 m depth (Huyer *et al.*, 1988). A little further to the south, during the summer there is an upper oxygen minimum at 300–500 m, a deep oxygen minimum at about 1500 m, and a salinity minimum from the Antarctic Intermediate Water at 700–1100 m (Harris *et al.*, 1987). The flow in the Bight is from west to east along the slope; on the western side of Tasmania, surface temperatures are lower than on the eastern side owing to the influence of the colder subantarctic waters (Rochford, 1975); on the eastern side, currents are more complex, becoming northward at depth but influenced by the warmer, shallower, East Australian Current and (at least in winter) by deeper water flowing out of the Bass Strait northwards (Godfrey *et al.*, 1980; Hamilton, 1990) with the result that “The waters around Tasmania are a mixture of both subtropical and subantarctic origin” (Harris *et al.*, 1987).

#### Materials and methods

We follow Andriashev & Stein (1998) for abbreviations and methods of counts and measurements with some important additions, described below. All specimens examined were preserved in ethanol, and little information was available

regarding colour in life. Collection location coordinates are averages of the start and finish coordinates of the trawl hauls. Institutional abbreviations are listed in Leviton *et al.* (1985).

#### Abbreviations for counts

|       |  |
|-------|--|
| A     | anal-fin rays  |
| C     | caudal-fin rays  |
| D     | dorsal-fin rays  |
| f     | fenestra in pectoral girdle; f1 is dorsalmost          |
| gr    | number of gill rakers on the outside of the first arch |
| P     | pectoral-fin rays                                      |
| r     | rudimentary pectoral-fin ray                           |
| R     | radial of pectoral girdle; R1 is dorsalmost            |
| pc    | pyloric caeca  |
| Vert. | vertebrae  |

#### Abbreviations for pores

Sensory pores of the cephalic series for *Careproctus* and *Paraliparis* are given in the order nasal (n), maxillary (m), preoperculo-mandibular (pm), and suprabranchial (s) (Andriashev *et al.*, 1977; Burke, 1930). The maxillary series includes infraorbital (i.o.<sub>1-5</sub>) and first temporal (= postorbital) (t<sub>1</sub>) pore. The suprabranchial pores (tsb<sub>1-2</sub>) are the last in the temporal series. For *Pseudnos*, the pores are described in greater detail in the generic and individual descriptions.

**Table 2.** Ranges and limits of variation of selected proportional measurements, specifying species with morphometry near the extremes, and providing guidelines for use of relative terminology in Australian *Paraliparis* only. Minimum or lower (min) values of a range on left side, maximum or higher (max) values on right side; shading distinguishes each measurement.

| min   | term       | measurement and selected species   | term      | max  | min  | term   | measurement and selected species  | term      | max       |
|---|------------|--|-----------|------|--|--------|---|-----------|-----------|
| <b>head (HL) as % SL: 17.7–21.4</b>                         |            |  |           |      | <b>lower pectoral-fin lobe length (LPL) as % HL 37–85</b>    |        |   |           |           |
| 17.7  | short      | ..... sp. 2  | long      | 21.4 | 37   | short  | ..... <i>atrolabiatus</i>   |           |           |
|   |            | ..... <i>dewitti</i>   |           |      | 42   |        | ..... <i>retrodorsalis</i>  |           |           |
| <b>head width as % HL: 49–67</b>                            |            |  |           |      | <b>LPL as % UPL 61–95</b>                                    |        |   |           |           |
| 49  | compressed | ..... <i>eastmani</i>  | wide      | 67   | 46.5   |        | ..... sp. 1   | long      | 85        |
|   |            | ..... <i>dewitti, atrolabiatus</i>   |           |      |  |        | ..... <i>csiroi</i>   |           |           |
| <b>head depth as % HL 69–103</b>                            |            |  |           |      | <b>eye (E) as % HL 18.8–28.9</b>                             |        |   |           |           |
| 69  | shallow    | ..... <i>avellaneus</i>  |           |      | 18.8   | small  | ..... <i>tasmaniensis</i>   |           |           |
| 72  |            | ..... <i>infeliciter, sp. 2</i>  |           |      | 21.0   |        | ..... <i>labiatus, auriculatus, eastmani, hobarti, impariporus, obtusirostris</i>     | 25.4–26.0 |           |
|   |            | ..... <i>piceus</i>  |           | 93   |  |        | ..... <i>coracinus</i>  | 27.0      |           |
|   |            | ..... <i>impariporus</i>   | deep      | 103  |  |        | ..... <i>badius</i>   | long      | 95        |
| <b>body depth (bd) as % HL 69–132</b>                       |            |  |           |      | <b>postorbital length as % HL 45.2–53.5</b>                  |        |   |           |           |
| 69  | shallow    | ..... <i>badius</i>  |           |      | 45.0–45.2  | short  | ..... <i>hobarti, infeliciter, coracinus, impariporus, plagiostomus, tasmaniensis</i> | long      | 53.0–53.5 |
| 85  |            | ..... sp. 2  |           |      |  |        |   |           |           |
|   |            | ..... <i>australiensis, csiroi, tasmaniensis</i>                                       |           | 125  |  |        |   |           |           |
|   |            | ..... <i>coracinus, impariporus</i>  | deep      | 132  | <b>snout as % HL 27.8–37.5</b>                               |        |   |           |           |
| <b>body depth at anal-fin origin (bdA) as % HL 66–113</b>   |            |  |           |      | <b>interorbital width as % HL 30.1–48.3</b>                  |        |   |           |           |
| 66  | shallow    | ..... <i>badius</i>  |           |      | 30.1   | narrow | ..... <i>plagiostomus</i>   |           |           |
| 77–82   |            | ..... sp. 2, <i>avellaneus, gomoni, piceus</i>   |           | 108  | 31.3   |        | ..... <i>csiroi</i>   |           |           |
|   |            | ..... <i>impariporus</i>   |           | 111  | 34.3   |        | ..... <i>avellaneus, labiatus</i>   | 44.1      |           |
|   |            | ..... <i>tasmaniensis</i>  | deep      | 113  |  |        | ..... <i>ater</i>   | 47.0      |           |
|   |            |  |           |      |  |        | ..... <i>auriculatus</i>  | broad     | 48.3      |
| <b>predorsal length (pred) as % SL 16.1–28.3</b>            |            |  |           |      | <b>upper jaw as % HL 41.4–54.7</b>                           |        |   |           |           |
| 16.1  | short      | ..... <i>eastmani</i>  |           |      | 41.4   | short  | ..... <i>anthracinus</i>  |           |           |
| 18.5  |            | ..... sp. 2  |           |      | 42.5–42.6  |        | ..... sp. 1, <i>tasmaniensis, eastmani</i>  | 51.3      |           |
|   |            | ..... <i>lasti</i>   |           | 26.0 |  |        | ..... <i>lasti</i>  | 52.0      |           |
|   |            | ..... <i>impariporus</i>   |           | 26.8 |  |        | ..... <i>plagiostomus</i>   | long      | 54.7      |
|   |            | ..... <i>retrodorsalis</i>   | long      | 28.3 | <b>lower jaw as % HL 38.3–48.4</b>                           |        |   |           |           |
| <b>preanal fin length (preA) as % SL 29.0–40.3</b>          |            |  |           |      | <b>pyloric caeca as % SL 3.0–9.8</b>                         |        |   |           |           |
| 29.0  | short      | ..... <i>auriculatus</i>   |           |      | 3.0  | short  | ..... <i>dewitti</i>  |           |           |
| 30.1  |            | ..... <i>plagiostomus</i>  |           |      |  |        | ..... <i>australiensis</i>  | long      | 9.8       |
|   |            | ..... <i>impariporus</i>   |           | 40.0 | <b>gill opening as % HL 15.1–23.6</b>                        |        |   |           |           |
|   |            | ..... <i>costatus</i>  | long      | 40.3 | 15.1   | short  | ..... <i>badius</i>   |           |           |
| <b>mandible to anus (ma) as % SL 10–15</b>                  |            |  |           |      | 15.9   |        | ..... <i>atrolabiatus</i>   |           |           |
| 10.5  | short      | ..... <i>infeliciter</i>   |           |      | 15.9   |        | ..... <i>infeliciter</i>  |           |           |
| 10.9  |            | ..... <i>plagiostomus</i>  |           |      | 16.4   |        | ..... <i>auriculatus, obtusirostris</i>   | 22.7      |           |
| 11.4  |            | ..... <i>lasti</i>   |           |      |  |        | ..... <i>brunneocaudatus</i>  | 22.8      |           |
|   |            | ..... <i>ater, hobarti, impariporus</i>  | 14.5–14.8 |      |  |        | ..... <i>impariporus</i>  | long      | 25.6      |
|   |            | ..... <i>anthracinus, brunneocaudatus</i>  | long      | 15.0 | <b>lower pectoral-fin lobe length (LPL) as % SL 7.2–13.5</b> |        |   |           |           |
| <b>anus to anal fin (aAf) as % SL 15.9–30.0</b>             |            |  |           |      | 7.2  | short  | ..... <i>atrolabiatus</i>   |           |           |
| 15.9  | short      | ..... <i>badius</i>  |           |      | 8.5  |        | ..... <i>infeliciter</i>  |           |           |
| 16.7  |            | ..... <i>auriculatus</i>   |           |      | 8.8  |        | ..... <i>plagiostomus</i>   |           |           |
|   |            | ..... <i>retrodorsalis</i>   |           | 25.9 |  |        | ..... <i>gomoni</i>   | 12.8      |           |
|   |            | ..... <i>australiensis</i>   | long      | 30.0 |  |        | ..... <i>brunneocaudatus</i>  | 13.4      |           |
| <b>upper pectoral-fin lobe length (UPL) as % HL 60.5–83</b> |            |  |           |      |  |        | ..... <i>lasti</i>  | long      | 13.5      |
| 60.5  | short      | ..... <i>avellaneus</i>  |           |      |  |        |   |           |           |
| 62  |            | ..... <i>infeliciter</i>   |           |      |  |        |   |           |           |
| 63  |            | ..... <i>auriculatus, australiensis, dewitti, plagiostomus, brunneocaudatus, lasti</i> |           | 75   |  |        |   |           |           |
|   |            | ..... <i>gomoni</i>  |           | 76   |  |        |   |           |           |
|   |            | ..... <i>piceus</i>  |           | 78   |  |        |   |           |           |
|   |            | ..... <i>hobarti</i>   | long      | 83   |  |        |   |           |           |

**Abbreviations for measurements**

|      |   |
|------|---|
| aAf  | distance from centre of anus to anal-fin origin   |
| bd   | maximum body depth  |
| bdA  | body depth at anal-fin origin   |
| disk | longitudinal diameter of disk   |
| E    | eye diameter horizontally   |
| gs   | length of gill opening  |
| HL   | head length   |
| io   | interorbital width  |
| lj   | lower jaw length  |
| LPL  | greatest length of lower lobe of pectoral fin   |
| ma   | length from mandibular symphysis to centre of anus  |
| md   | length from mandibular symphysis to anterior edge of disk                                       |
| NL   | length of shortest notch ray  |
| po   | postorbital head length   |
| preA | preanal-fin length  |
| preD | predorsal-fin length  |
| sn   | snout length  |
| so   | suborbital distance, shortest distance between margin of eye and horizontal level of oral cleft |
| SL   | standard length   |
| uj   | upper jaw length  |
| UPL  | greatest length of upper lobe of pectoral fin   |

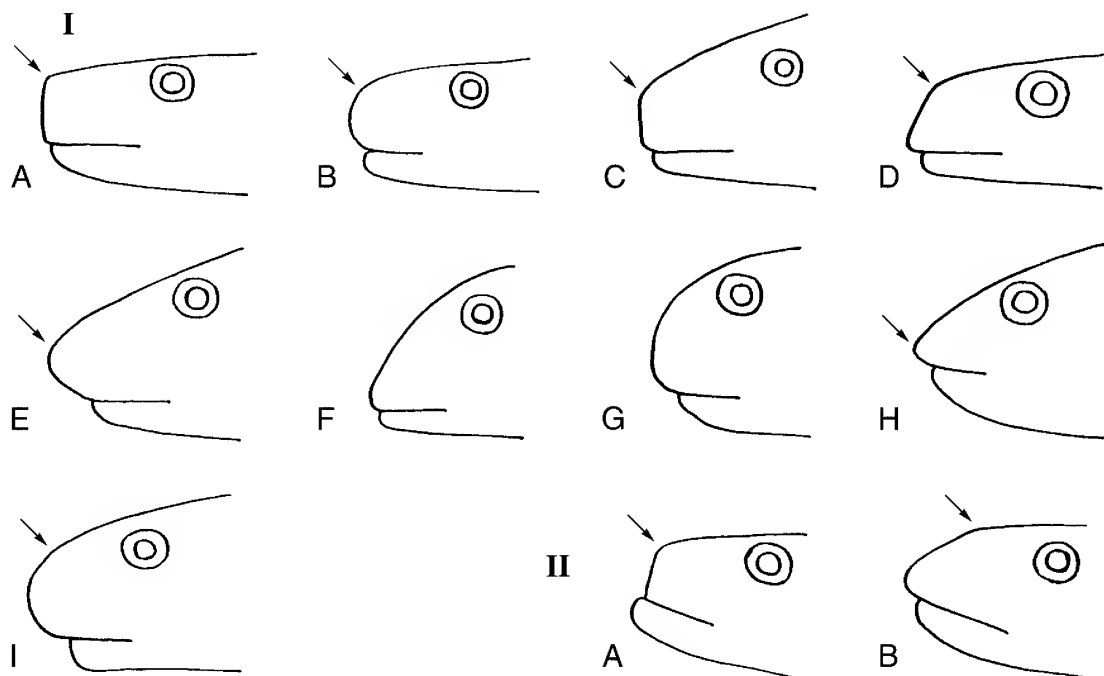
All proportions are in percent of SL followed by percent HL (in parentheses or specified). Paratype measurements are in square brackets. For pectoral girdle methods and discussion, see Andriashev & Stein (1998). Cephalic pores were usually studied by injection, using the method of Matsubara & Iwai (1954). We use the term “chin pores” for the symphysiomandibular pore or pores.

Identification of many of the new *Paraliparis* species is

very difficult because they differ in details that are hard to quantify; many of these characters have not previously been used in liparid taxonomy. Therefore, we have expanded or added to the descriptive terminology used in identifying them for the snout, eye position, suborbital distance (defined above), mouth position, lower jaw position, chin pores, opercular flap, and body shape. Below, for each of these characters, we provide descriptions of each character and character state, figures where necessary, and list the new species as they fit each character state. We provide guidelines for use of relative terminology in the species considered herein by listing the extremes for selected proportions and naming the species displaying them (Table 2). Unfortunately, for some characters, judgement of state is unavoidably highly subjective. Therefore, if there is any doubt regarding the existing state in a specimen, it is absolutely necessary to refer to the appropriate figure before making a decision about its character state.

**Snout** (Fig. 2). We follow the traditional method of snout measurement, i.e., from most anterior point of upper lip or tip of snout to anterior margin of orbit (Hubbs & Lagler, 1949). Among the Australian *Paraliparis*, there is a wide variety of snout shape, length, and depth. They are:

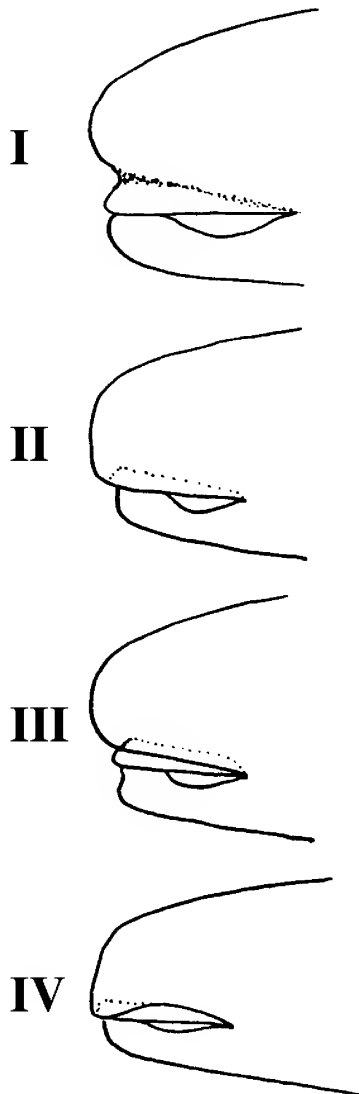
- I Mouth horizontal
- A Snout deep, blunt, not protruding anterior to mouth: *australiensis*, *csiroi*, *gomoni*, *obtusirostris*
  - B Snout deep, rounded, slightly projecting: *costatus*, *dewitti*, *hobarti*, *infeliciter*, *tasmaniensis*, sp. 2



**Figure 2.** Shape of snout. I, mouth horizontal: A, deep blunt, not protruding anterior to mouth; B, deep rounded, slightly projecting; C, deep, bluntly rounded; D, deep, slanted, projecting; E, shallow, rounded, projecting; F, abruptly angled; G, deep, rounded; H, acutely angled. I, deep, rounded, greatly projecting. II, mouth oblique: A, deep, blunt; B, angled, projecting.

- C Snout deep, bluntly rounded: *anthracinus*, *ater*, *labiatus*, *piceus*
  - D Snout deep, slanted, projecting: *badius*
  - E Snout shallow, rounded, projecting: *atrolabiatus*, sp. 1
  - F Snout abruptly angled: *auriculatus*
  - G Snout deep, rounded: *brunneus*, *coracinus*, *impariporus*
  - H Snout acutely angled: *retrodorsalis*, *tasmaniensis*
  - I Snout deep, rounded, greatly projecting: *delphis*, *lasti*, *plagiostomus*
- II Mouth oblique
    - A Snout deep, blunt: *avellaneus*, *eastmani*
    - B Snout angled, projecting: *brunneocaudatus*

**Subrostral fold** (Fig. 3). The subrostral fold is a fold of skin (with gelatinous tissue internally) that forms part of the ventral surface of the snout immediately anterior to the



**Figure 3.** Subrostral fold. I, absent; II, deep, covering upper lip entirely; III, present, but not covering upper lip entirely; IV, deep anteriorly, shallower posteriorly.

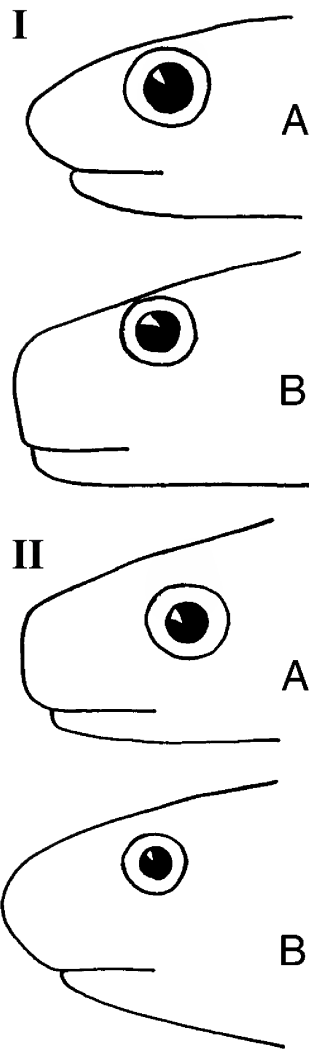
upper lip. If present, it may cover the upper jaw entirely or to various degrees. In our *Paraliparis* specimens, we identified four character states:

- I Absent: *anthracinus*, *badius*, *coracinus*, *csiroi*, *hobarti*, sp. 1, sp. 2
- II Deep, covering upper lip entirely: *avellaneus*, *brunneocaudatus*, *plagiostomus*
- III Present, but not covering upper lip entirely:
  - A Almost absent, barely covering some of upper lip: *ater*
  - B Covering about half of upper jaw: *atrolabiatus*, *dewitti*, *lasti*, *obtusirostris*, *retrodorsalis*
  - C Covering about  $\frac{3}{4}$  of upper jaw: *costatus*, *infeliciter*
  - D Covering upper jaw almost, but clearly not quite entirely: *auriculatus*, *australiensis*, *brunneus*, *eastmani*, *gomoni*, *impariporus*, *tasmaniensis*
- IV Deep, covering most of upper lip anteriorly, shallower posteriorly: *delphis*, *labiatus*, *piceus*

**Eye position and suborbital distance** (Fig. 4). The height of the eye in relation to the profile of the head is a significant character. It may actually enter the lateral profile and is located at various distances above the mouth. We found two categories of variation in our *Paraliparis* specimens, each with two subcategories:

- I Eye high, nearly touching dorsal contour of head
  - A Suborbital distance short (0.5–0.6 eye diameter): *australiensis*, *avellaneus*, *badius*, sp. 2
  - B Suborbital distance long (0.7–1.0 eye diameter): *brunneus*, *coracinus*, *delphis*, *gomoni*, *obtusirostris*, *piceus*, *retrodorsalis*, *tasmaniensis*, sp. 1
- II Eye low, not touching dorsal contour of head
  - A Suborbital distance short (0.5–0.6 eye diameter): *auriculatus*, *brunneocaudatus*, *csiroi*, *eastmani*, *hobarti*, *impariporus*, *infeliciter*, *lasti*
  - B Suborbital distance long (0.7–0.9 eye diameter): *anthracinus*, *ater*, *atrolabiatus*, *costatus*, *dewitti*, *labiatus*, *plagiostomus*

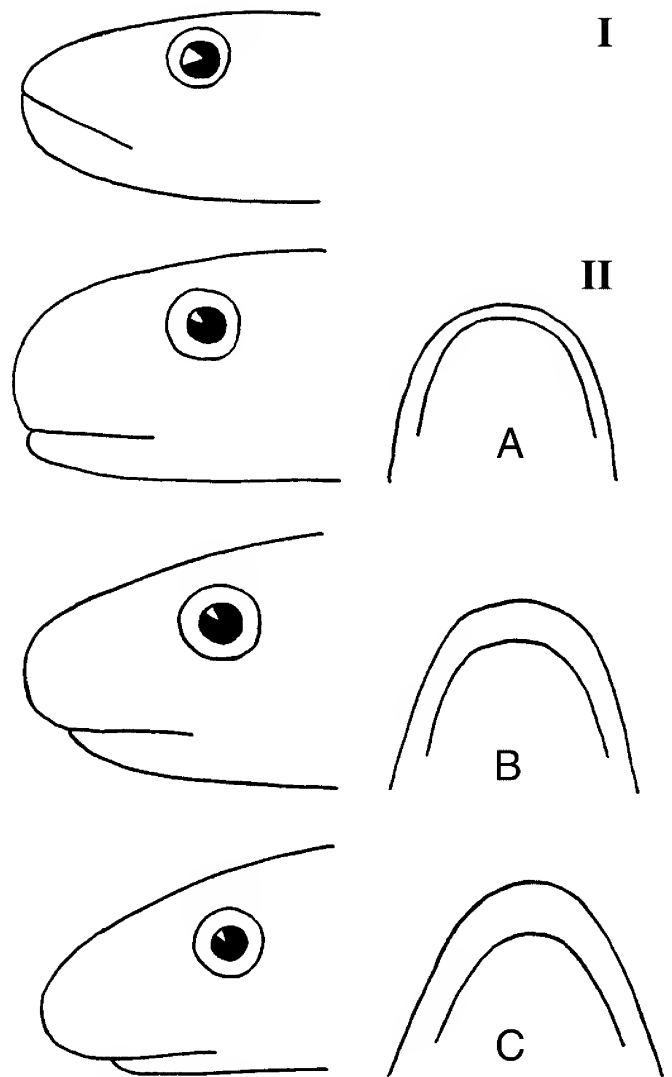
**Mouth position** (Fig. 5). Two character states are represented in our *Paraliparis* material: horizontal and oblique. When the mouth is horizontal, the symphysis of the upper jaw is clearly below eye level; when it is oblique, the symphysis of the upper jaw is level with or above the lower margin of the eye. A horizontal mouth may be terminal, subterminal, or inferior. A terminal mouth is one in which the symphyses of the upper and lower jaws are located at the extreme anterior end of the fish, with the snout not projecting; an inferior mouth is one located below a greatly projecting snout, on the lower (flat) surface of the head (similar to that in some sharks); a subterminal mouth is intermediate between the two states, in which the snout projects slightly, and the ventral surface of the head is rounded, not flat, with the lower jaw usually, but not always, deep below the posterior of the oral cleft.



**Figure 4.** Eye position and suborbital distance. I, eye high, nearly touching dorsal contour of head: A, suborbital distance short (0.5–0.6 eye diameter); B, suborbital distance long (0.7–1.0 eye diameter). II, eye low, not touching dorsal contour of head: A, suborbital distance short (0.5–0.6 eye diameter); B, suborbital distance long (0.7–0.9 eye diameter).

- I Mouth oblique: *avellaneus*, *brunneocaudatus*, *eastmani*
- II Mouth horizontal:
- A Terminal: *australiensis*, *costatus*, *csiroi*, *gomoni*, *labiatus*, *obtusirostris*, *piceus*
- B Subterminal: *anthracinus*, *ater*, *atrolabiatus*, *auriculatus*, *brunneus*, *coracinus*, *delphis*, *dewitti*, *hobarti*, *impariporus*, *infeliciter*, *lasti*, *retrodorsalis*, *tasmaniensis*, sp. 1, sp. 2
- C Inferior: *badius*, *plagiostomus*

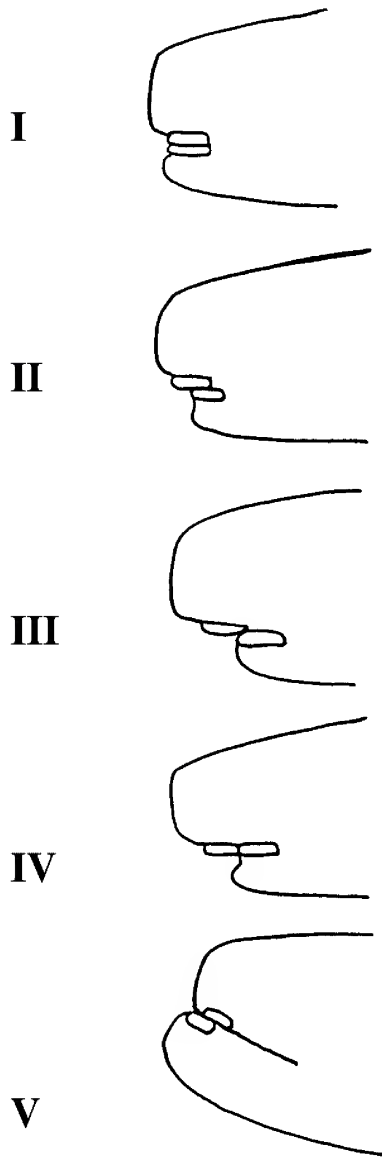
**Lower jaw position** (Fig. 6). We found five different lower jaw character states in *Paraliparis* based on the relationships of the tooth plates in both the upper and lower jaws when the jaws are closed and viewed ventrally. We define “included lower jaw” as one in which the upper tooth plates can be seen clearly and completely from directly below when the upper lip fold is pushed out of the way.



**Figure 5.** Mouth position. I, mouth oblique. II, mouth horizontal: A, terminal; B, subterminal; C, inferior.

“Subterminal lower jaw” is one where the tooth plates of the upper and lower jaws meet more or less completely, but the upper jaw extends anterior to the lower jaw. “Terminal lower jaw” is the case where the upper jaw does not project anterior to the lower jaw. The “diastema” is the gap between the left and right tooth plates, present or absent in either or both jaws.

- I Terminal: upper tooth plates exactly mating with lower plates: *labiatus*
- II Subterminal: lower tooth plates somewhat behind upper tooth plates, but clearly overlapping: *ater*, *atrolabiatus*, *costatus*, *hobarti*, *impariporus*, *obtusirostris*, *piceus*, *plagiostomus*, *tasmaniensis*
- III Subterminal, almost included: lower tooth plates barely overlapping posterior of upper tooth plates: *auriculatus*, *australiensis*, *brunneus*, *infeliciter*, sp. 2
- IV Included: lower tooth plates entirely within

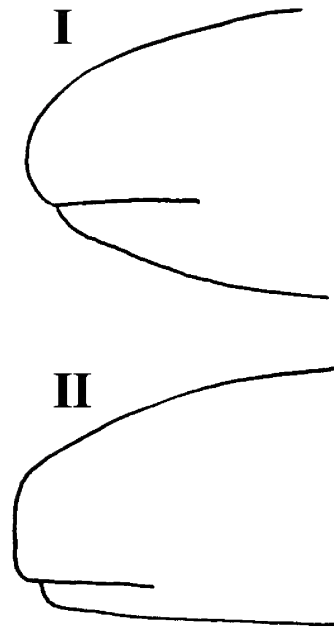


**Figure 6.** Lower jaw position. I, terminal: upper tooth plates exactly mating with lower plates. II, subterminal: lower tooth plates somewhat behind upper tooth plates, but clearly overlapping. III, subterminal, almost included: lower tooth plates barely overlapping posterior of upper tooth plates. IV, included: lower tooth plates entirely within posterior margin of upper tooth plates. V, projecting: lower tooth plates partially anterior to upper tooth plates.

posterior margin of upper tooth plates:  
*anthracinus, avellaneus, badius, brunneocaudatus, coracinus, csiroi, delphis, dewitti, gomoni, lasti, retrodorsalis*, sp. 1

V Projecting: lower tooth plates partially anterior to upper tooth plates: *eastmani*

**Lower jaw depth** (Fig. 7). The lower jaw can be deep or shallow at the point below the posterior of the oral cleft. In general, deep jaws are related to a rounded ventral cross-section of the body, and shallow ones to a flat ventral surface:



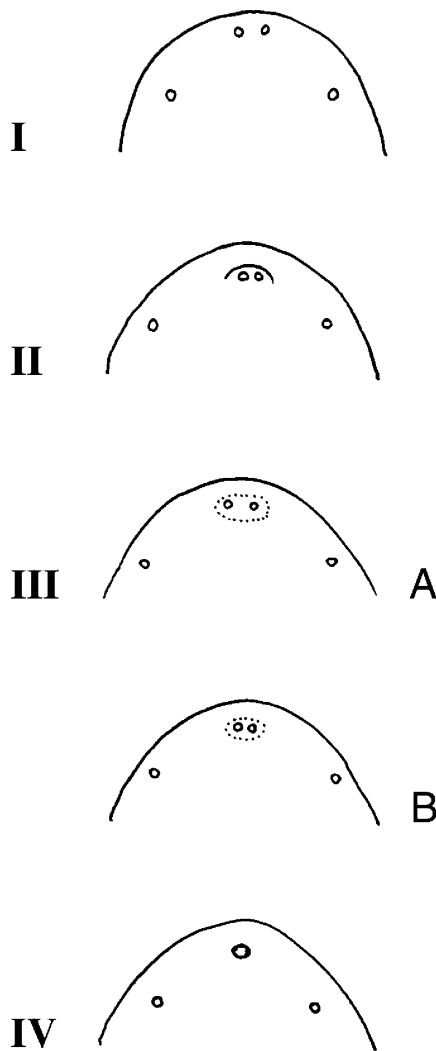
**Figure 7.** Lower jaw depth. I, jaw relatively deep. II, jaw relatively shallow.

- I Jaw relatively deep: *anthracinus, atrolabiatus, auriculatus, brunneocaudatus, brunneus, coracinus, delphis, dewitti, eastmani, impariporus, lasti, retrodorsalis, tasmaniensis*, sp. 1, sp. 2
- II Jaw relatively shallow: *ater, australiensis, badius, csiroi, gomoni, hobarti, infeliciter, labiatus, obtusirostris, piceus, plagiostomus*

**Chin pores** (Fig. 8). The mandibular symphyseal (chin) pores are usually distinctly separated by an interspace. In one species, *P. impariporus*, the pores are fused to form a single pore in which the canals enter from each side. In all other species treated here, two (normal) pores are present. We have found it necessary to expand the terminology describing paired chin pores. Three states exist in our *Paraliparis* material:

- I At the surface: two pores are present, opening directly and separately on the skin surface, or opening into a poorly-defined shallow depression not marked by an edge. Anterior skin fold absent, anterior and posterior pores similar: *avellaneus, brunneocaudatus, costatus, eastmani, hobarti, lasti, piceus, plagiostomus, retrodorsalis, tasmaniensis*
- II With a crescent-shaped skin fold anterior to the pores but not extending posterior to them. Pore depression absent in *anthracinus, ater, atrolabiatus, auriculatus, badius, brunneus, coracinus, delphis, labiatus*; only in one species are pores in a poorly-defined, shallow depression posterior to skin fold: *obtusirostris*
- III In a wide, oval, shallow depression or pit: two chin pores open into a common clearly-defined shallow pit, with edges formed by skin folds;
  - A Interspace equal to about two pore diameters: *dewitti*





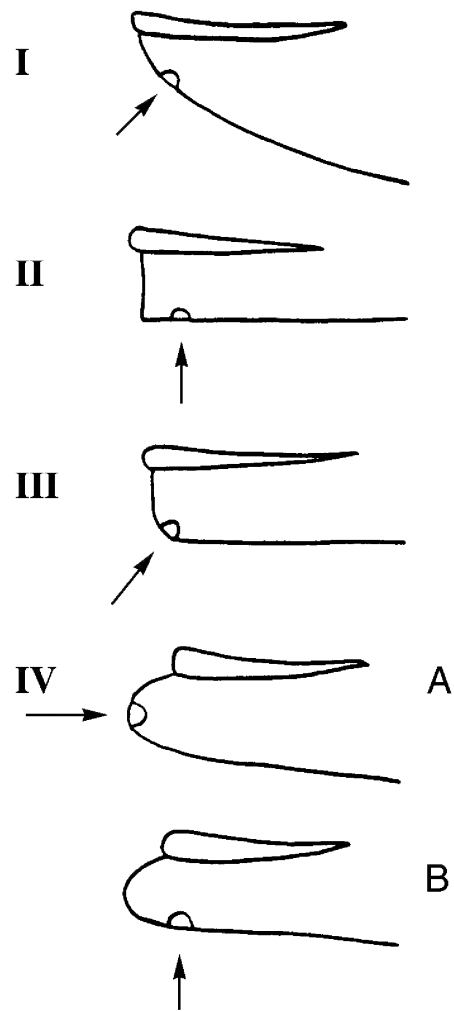
**Figure 8.** Chin pores. I, at the surface: two pores are present, opening directly and separately on the skin surface, or into a poorly-defined shallow depression not marked by an edge; anterior skin fold absent, pores similar in morphology to those located more posteriorly on the canals. II, with a crescent-shaped skin fold anterior to the pores but not extending posterior to them. III, two chin pores open into a common wide, oval, shallow pit, with sharply defined edges: A, interspace equal to about two pore diameters; B, interspace equal to about one pore diameter or less (one species with pit on anterior surface of symphysis). IV, a single pore present.

B Interspace equal to about one pore diameter or less: *australiensis*, *csiroi* (in a pit on anterior surface of symphysis), *gomoni*, *infeliciter*, sp. 1, sp. 2

IV A single pore present: *impariporus*

**Chin shape and chin pore position** (Fig. 9). Shape and structure of the chin (tip of the lower jaw) varies significantly among the *Paraliparis* species. There are four states:

I In lateral profile, chin slanted at about 45°: *ater*, *auriculatus*, *avellaneus*, *badius*, *brunneocaudatus*, *brunneus*, *coracinus*, *eastmani*, *impariporus*, *infeliciter*, *lasti*, *plagiostomus*, *retrodorsalis*, *tasmaniensis*, sp. 1, sp. 2



**Figure 9.** Diagram of chin state and chin pore position. Arrow points to left-hand chin pore. I, in lateral profile, chin slanted at about 45°. II, chin profile distinctly right-angled, with sharp firm edge; chin pores on ventral surface. III, chin profile vertical but with rounded edge; chin pores on ventral surface. IV, chin margin gelatinous, projecting anteriorly: A, chin pore-pit on anterior surface, not ventral; B, chin pore pit on ventral surface.

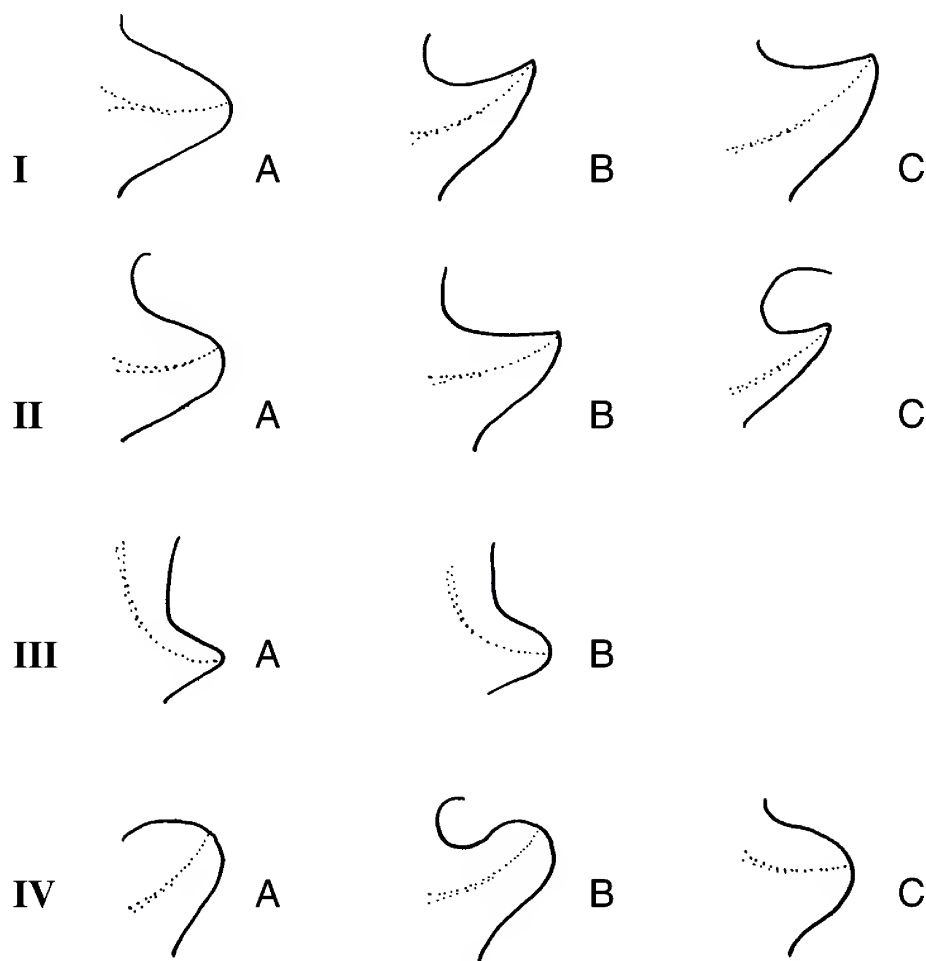
II Chin profile distinctly right-angled, with sharp, firm edge. Chin pores on ventral surface: *anthracinus*, *gomoni*, *labiatus*, *obtusirostris*, *piceus*

III Chin profile vertical with rounded edge: *atrolabiatus*, *australiensis*, *costatus*, *delphis*, *hobarti*

IV Chin margin gelatinous, projecting anteriorly  
A Chin pore-pit on anterior surface, not ventral: *csiroi*

B Chin pore pit on ventral surface: *dewitti*

"Honeycomb" tissue occurs on the lower jaw of some species but not in others; it looks like a thick subdermal layer of honey-comb with empty "cells". We suspect that in life, these cells are filled with gelatinous material common in liparids. We do not know the function of this tissue, nor



**Figure 10.** Opercular flap. I, covering gill opening for its entire length: A, triangular with equal sides; B, sharp tipped, dorsally notched at anterior base; C, tip blunt, dorsal notch absent. II, covering lower  $\frac{2}{3}$  of gill opening: A, tip rounded; B, tip sharp; C, tip sharp, anterior dorsal notch prominent. III, covering lower half or less of gill opening: A, tip triangular; B, tip rounded. IV, other variants: A, dorsally rounded; B, ear-shaped; C, rounded.

of analogous structures in other fishes. Its occurrence is unrelated to depth of chin below the rear end of the mouth cleft. It is clearly present in *coracinus*, *impariporus*, *infeliciter*, *labiatus*, *retrodorsalis*, *tasmaniensis*, and sp. 1, and absent in *P. gomoni*. The last was the only species with damaged lower jaw skin in which honeycomb tissue was absent. Because we wished to do as little damage as possible to the specimens, we did not look for its presence in the lower jaws of specimens that were unskinned, and therefore, the condition in all species not listed above is unknown.

**Opercular flap** (Fig. 10). The opercular flap, which covers the gill opening, although easily damaged during capture, provides useful characters for identification. Shape, presence or absence of a dorsal notch, amount of pectoral-fin overlap, and position of the flap in relation to the gill opening can all be useful in identifying species. Position of the gill opening relative to the eye and orbit may also be useful. For instance, the ventral end is even with or above the upper margin of the pupil in *P. plagiostomus* and *P. badius*, but is even with or below the ventral margin of the eye in *P. brunneocaudatus* and *P. costatus*.

I Opercular flap covers gill opening for its entire length.

- A Triangular with equal sides: *dewitti*, sp. 2
- B Sharp tipped, dorsally notched: *anthracinus*, *impariporus*, sp. 1
- C Ventral margin rounded: *delphis*

- II Opercular flap covers lower  $\frac{2}{3}$  of gill opening.
  - A Tip rounded: *avellaneus*, *hobarti*, *obtusirostris*
  - B Tip blunt, dorsal notch absent: *eastmani*, *gomoni*
  - C Tip sharp, anterior dorsal notch prominent: *coracinus*, *infeliciter*, *retrodorsalis*, *tasmaniensis*

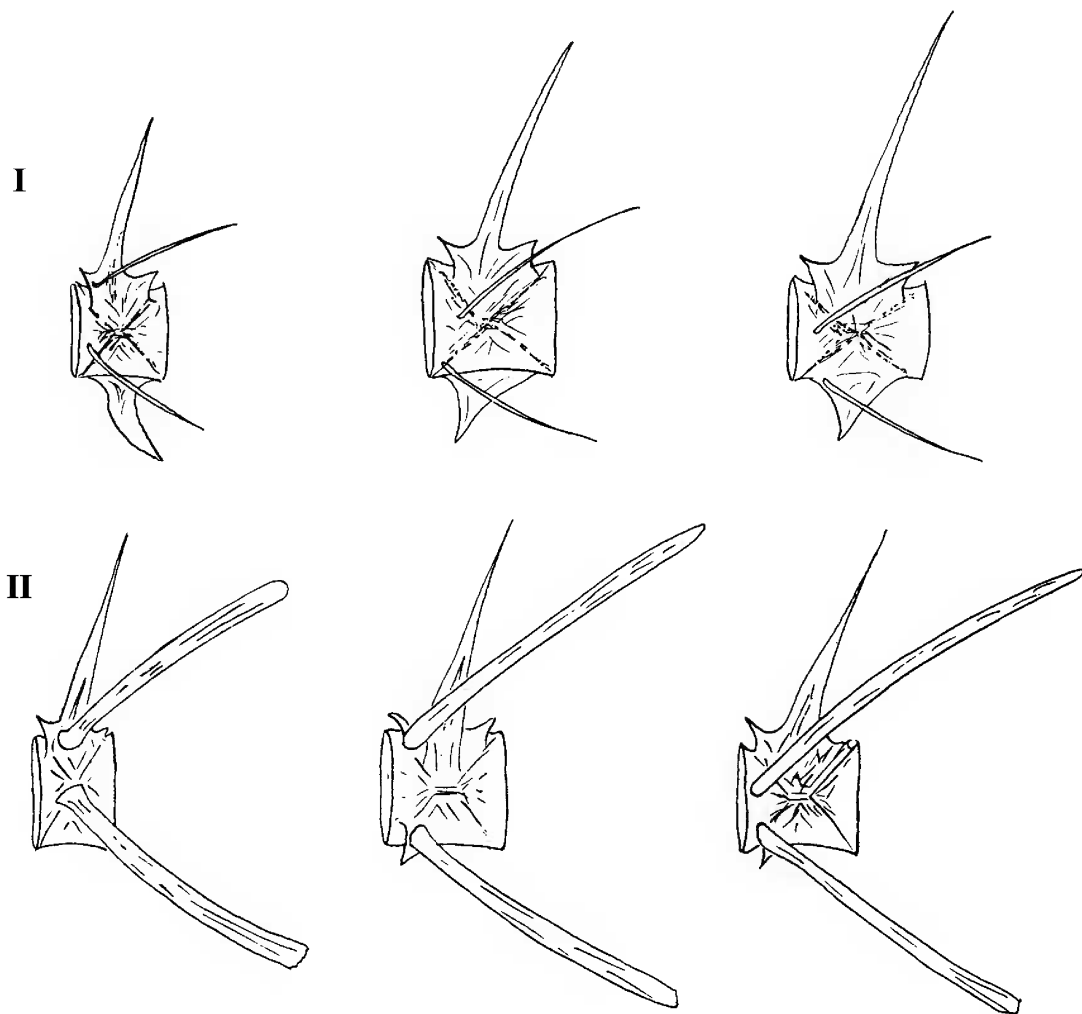
- III Opercular flap covers lower half or less of gill opening.
  - A Tip triangular: *ater*, *lasti*
  - B Tip rounded: *costatus*

- IV Other variants
  - A Dorsally rounded: *piceus*
  - B Anthropoid ear-shaped: *auriculatus*, *australienensis*, *brunneocaudatus*, *csiroi*, *labiatus*
  - C Rounded: *atrolabiatus*, *badius*, *brunneus*, *plagiostomus*

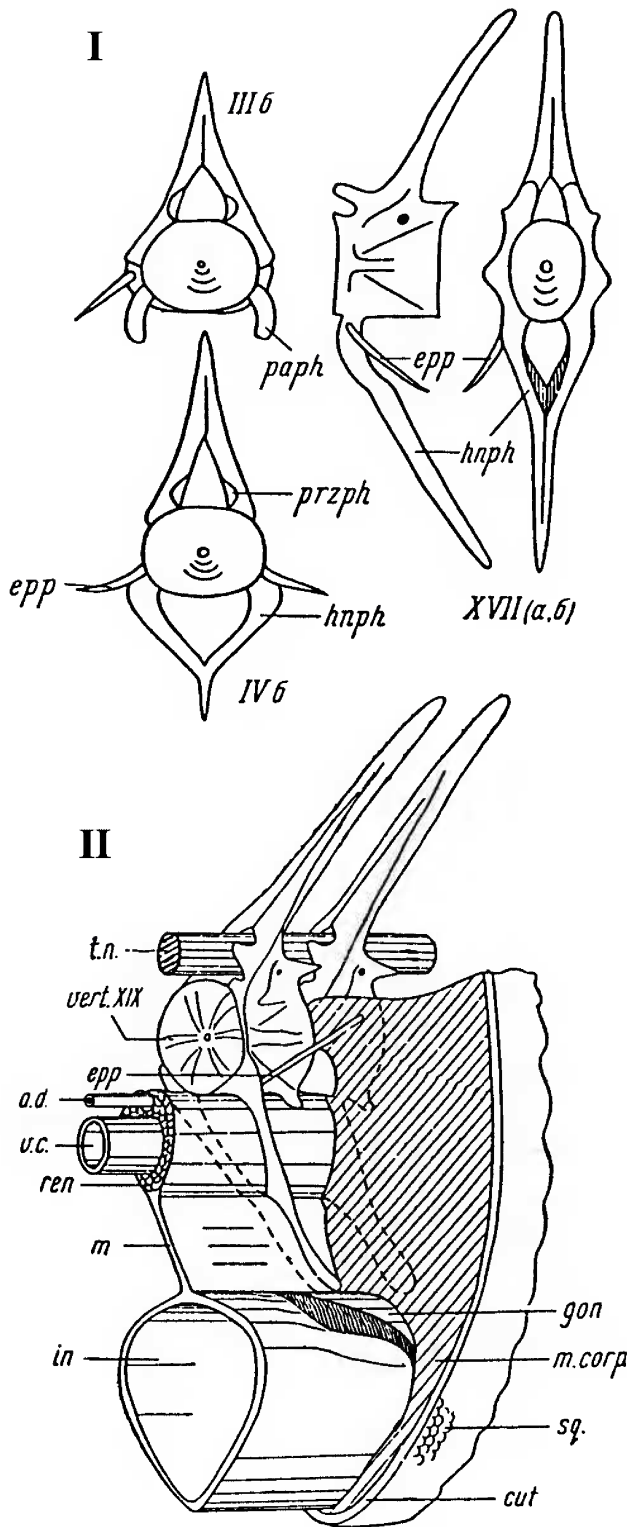
**Costal ridge** (Fig. 11). Several of our new species have a previously undescribed character state of the epineural and epipleural ribs (pleural ribs are absent in *Paraliparis*). Although these ribs are present in all species we examined, they are usually relatively short and slender and do not reach the surface of the body musculature. In *P. costatus*, *P. dewitti*, *P. lasti*, sp. 2, and in the damaged specimens of *Paraliparis* sp. (cf. *copei* group), the ribs are long, well developed, and reach the muscle surface along the anterior dorsal edge of the body cavity. Their tips can be clearly felt, and form a serrated ridge. In a number of other species (*ater*, *auriculatus*, *atrolabiatus*, *australiensis*, *brunneus*, *coracinus*, *delphis*, *hobarti*, *retrodorsalis*), this ridge is barely present owing to less well-developed ribs. In all other species, it is absent. Therefore, to determine the state of development of these ribs in most species, radiographs are necessary.

**Nephrohaemal canal** (Fig. 12). In most liparids, the parapophyses of the abdominal vertebrae are fork-like and unfused, except for those on the last one or two abdominal vertebrae, where they are joined to form a short haemal

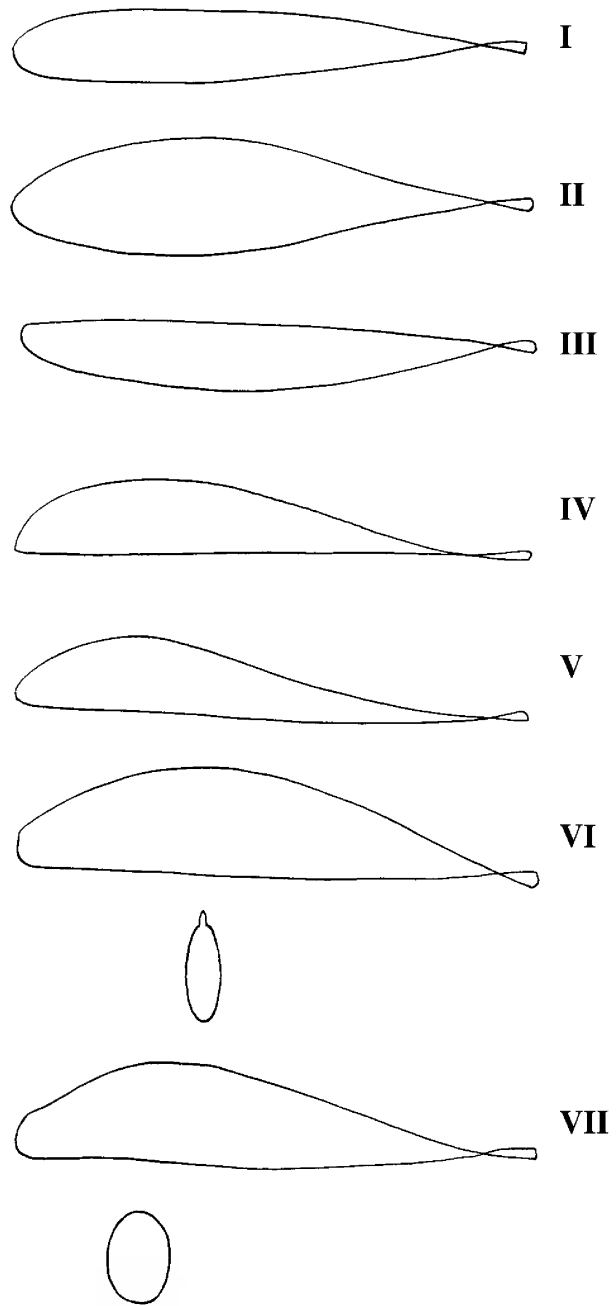
spine that does not reach the anal-fin pterygiophores (Andriashev & Stein, 1998). Although we were unable to dissect specimens owing to scarcity of material, radiographs clearly showed that in four species (*ater*, *atrolabiatus*, *csiroi*, *delphis*) the parapophyses of abdominal vertebrae 3–11 and 5–11 respectively are joined distally, creating foramina which in series form a canal. This structure also occurs in *piceus* but was only visible on vertebrae 9–11. These species do not appear to be close relatives, because there are differences among them in chin pore arrangement and number of pectoral radials. A similar structure was described in Pholidae (Andriashev, 1954; Hubbs, 1927: 388; Makushok, 1958) which included not only blood vessels but kidney tissue, which they named the “haemonephropophyses” and “nephrohaemal canal”. Because the structure in these *Paraliparis* species seems to be the same, we use the same term for it. Its occurrence in Pholidae is presumably related to the compression of the body, but in many other similarly-shaped fishes the parapophyses are normal (Chabanaud, 1951). Analogous structures are also known in Scombridae (Kishinouye, 1923: 338), *Zeus faber* (Ford, 1937), and some Pleuronectiformes (Chabanaud, 1951).



**Figure 11.** Epineural and epipleural ribs on vertebrae 3, 5, and 7. I, *Paraliparis australiensis*, holotype, NMV A21497, ♀, 176 mm TL, 164 mm SL. II, *Paraliparis costatus*, holotype, CSIRO H561-02, ♂, 224 mm TL, 204 mm SL.



**Figure 12.** Nephrohaemal canal (from Makushok, 1958). I—vertebral structure of *Pholis gunnelus*; a, lateral view; b, frontal view; epp, epipleural; hnph, haemonephrapophysis; III, IV, XVII, numbers of vertebrae; paph, parapophysis; przph, praezygapophysis. II—schematic of abdominal cross-section of *Pholis pictus*; a.d., aorta dorsalis; cut, skin; epp, epipleural; gon, testes; in, intestine; m, mesentery; m.corp., abdominal musculature; ren, kidney; sq, scales; t.n., spinal cord; v.c., vena cava; XIX, 19th vertebra. Dorsal musculature not shown.



**Figure 13.** Body shape. I, elliptic, shallow; II, elliptic, deep; III, dorsal profile straight; IV, ventral profile straight, not dorsally humpbacked; V, ventral profile straight, dorsally humpbacked; VI, ventral profile straight, body leaf-like, compressed; VII, dorsal and ventral contours curved, dorsal much more so, body humpbacked, not compressed.

**Body shape** (Fig. 13). Body shape can be useful only in specimens that have not been badly damaged or contorted during capture or preservation.

- I Elliptic, shallow: *ater*, *brunneus*, *costatus*, *gomonii*, *hobarti*, *infeliciter?*, *retrodorsalis*, sp. 2
- II Elliptic, deep: *anthracinus*, *australiensis*, *labiatus*, *tasmaniensis*
- III Dorsal profile straight: *avellaneus*, *brunneocaudatus*, *eastmani*, sp. 1
- IV Ventral profile straight, not dorsally humpbacked:

- auriculatus, atrolabiatus, badius, impariporus*
- V Ventral profile straight, dorsally humpbacked: *coracinus, delphis, dewitti, lasti, plagiostomus*
- VI Ventral profile straight, body leaf-like, compressed: *csiroi, piceus*
- VII Dorsal and ventral contours curved, dorsal much more so, body humpbacked, not compressed: *obtusirostris*

**Species groups.** To facilitate identification, we have divided the new *Paraliparis* species into three groups based on mouth position and chin pore characters. These groups do not necessarily represent phylogenetic relationships or real genetic similarity.

- I Mouth oblique: *avellaneus, brunneocaudatus, eastmani*

- II Mouth horizontal and inferior: *badius, plagiostomus*
- III Mouth horizontal, terminal or subterminal with symphyseal chin pores in three states:
- a Not in a pit or depression and lacking anterior skin fold: *costatus, hobarti, impariporus, lasti, piceus, retrodorsalis, tasmaniensis*
- b In a pit: *australiensis, csiroi, dewitti, gomoni, infeliciter, obtusirostris*, sp. 1, sp. 2
- c With an anterior skin fold: *anthracinus, ater, atrolabiatus, auriculatus, brunneus, coracinus, delphis, labiatus*

We describe and discuss each species within this context. Owing to the great similarities of some of these species, our key is not a full field key. In many cases, it will be necessary to perform dissections, use a dissecting microscope, radiograph, or to clear and stain certain structures.

### Key to genera of Australian liparids

- 1 Ventral sucking disk present ..... *Careproctus* Krøyer, 1862  
 — Ventral sucking disk absent ..... 2
- 2 Clearly humpbacked at occiput. Dorsal-fin rays 50 or fewer. Upper nasal pore ( $n_2$ ) above or posterior to nostril. Mouth always oblique ..... *Pseudnos* Barnard, 1927  
 — Not humpbacked at occiput, but may be humpbacked more posteriorly. Dorsal-fin rays 57 or more. Upper nasal pore ( $n_2$ ) anterior to nostril. Mouth usually horizontal ..... *Paraliparis* Collett, 1878

### Species descriptions

#### Genus *Careproctus* Krøyer, 1862

*Careproctus* Krøyer 1862: 253 (type species *Liparis reinhardtii* Krøyer, by monotypy).—Garman, 1892: 71; Jordan & Evermann, 1898: 2129; Burke, 1912: 507; 1930: 95; Stein, 1978b: 75; Kido, 1988: 192; Andriashev, 1998: 258; Andriashev & Stein, 1998: 5.

**Diagnosis.** One pair of nostrils (a single nostril on each side of snout). Pseudobranch absent. Ventral sucking disk present, small to large. Pectoral fins with or without developed lower lobe, notch variable, typically with fewer rays than anal fin. Body colour not variegated. About 45 Southern Hemisphere species known, 30 from the Southern Ocean (Andriashev & Stein, 1998), about 15 from the cool temperate Pacific and Atlantic coasts of South America (Andriashev & Stein, 1998), and one from Australia (this paper).

**Comparative notes.** The trenchant differences between the genus *Careproctus* and other liparid genera having ventral sucking disks, the most speciose of which is *Liparis*, are absence of pseudobranchiae and presence of single nostrils (v. a pair on each side of the snout). In addition, many *Careproctus* have more pectoral-fin rays than dorsal or anal-fin rays and have simple teeth whereas the other genera tend to have more longitudinal than pectoral-fin rays, and have trilobed teeth. Generally, *Careproctus* occurs at greater

depths than the others, and is distributed worldwide at depths from the intertidal to over 6000 m, whereas they do not occur in the Southern Hemisphere. Its morphological variability, represented by reduction in body structure, reflects its great depth range (Andriashev & Stein, 1998).

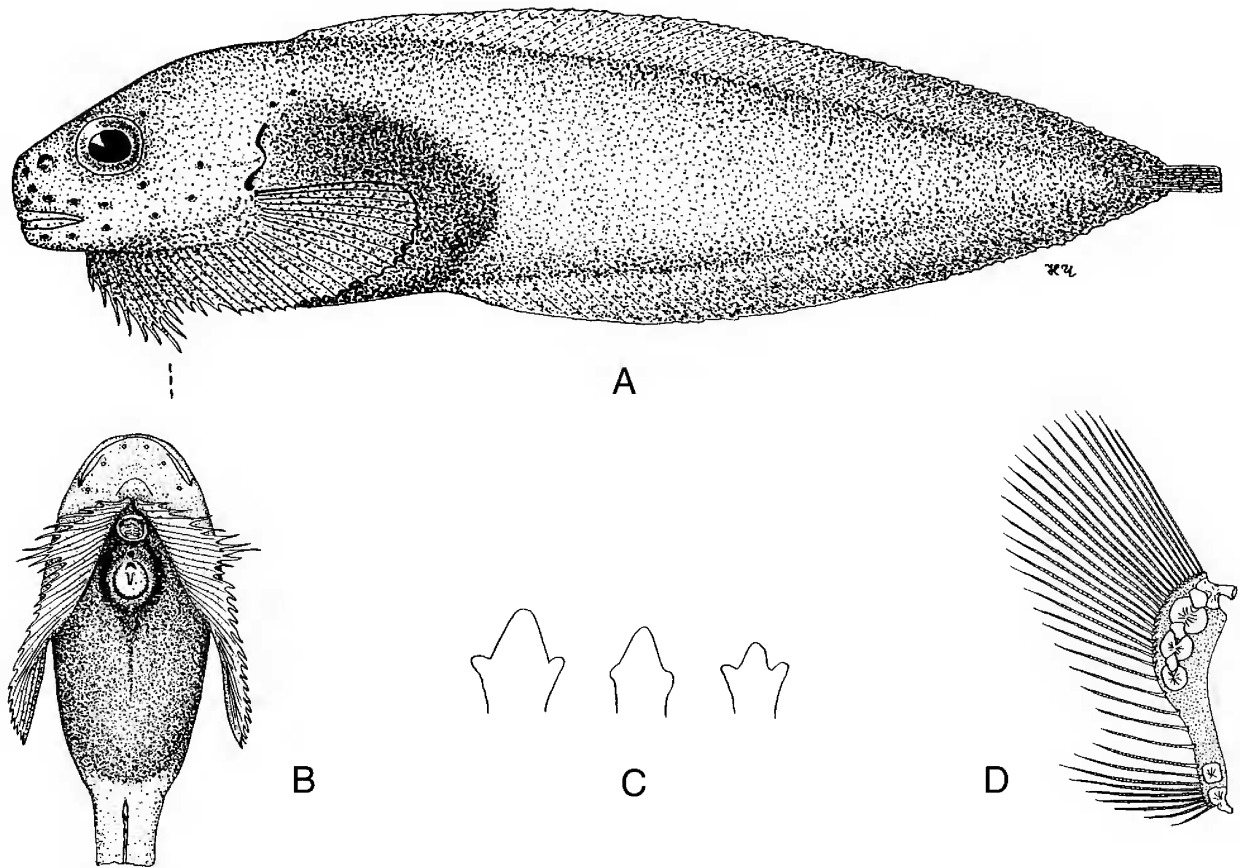
#### *Careproctus paxtoni* n.sp.

Fig. 14

**Material examined.** HOLOTYPE AMS I29737-003, ♀, 150 mm TL, 134 mm SL. FRV *Kapala*, 35°29'S 150°55'E, New South Wales, E of Brush I., 1116–1134 m, 31 Aug. 1989; radiograph 29737-1; pectoral girdle 725. PARATYPE AMS I29802-001, ♀, 155 mm TL, 144 mm SL; FRV *Kapala*, 35°28.5'S 150°53.5'E, New South Wales, SE of Ulladulla, 1061–1088 m, 30 May 1989; radiograph 29737-003; pectoral girdle 726.

**Diagnosis.** Vert. 58–59 (10+48–49), D 53–54, P 34–35, C 10–11 (1+4/5+0–1), radials 4 (3+1), notched, three interradial fenestrae present. Pleural ribs present. Hypural plate single, unsplit. Mouth terminal. Teeth shouldered, tricuspid, not sharp. Two suprabranchial pores present. Gill opening entirely above pectoral-fin base. Ventral disk very small, about 3% SL. Head 23–24%, preanal 45–46%. Peritoneum black, stomach pale to dusky.

**Further description.** Counts: D 53 [54], A 46 [47], P 34 [35], C 10 [11], Vert. 58 [59], radials 4 [4] notched,



**Figure 14.** *Careproctus paxtoni* n.sp. A, holotype, AMS I29737-003, ♀, 150 mm TL, 134 mm SL; B, ventral view; C, teeth; D, P 725, cleared and stained right pectoral girdle.

interradial fenestrae 3 [3], pores 2-6-7-2, gr 8 [9], pc 13. Ratios: HL 23.7 [22.8], its width 18.3 [—], its depth 23.7 [—], preD 28.2 [27.8], preA 45.1 [46.2], disk 3.0 [3.1], md 7.9 [9.2], ma 11.5 [—], UPL 14.9 [16.2], NL 9.0 [—], LPL 10.4 [9.9], E 6.2 [5.4], uj 9.9 [9.0], lj 8.6 [8.9], gs 9.0 [—]; in %HL: UPL — [63], disk 12.7 [13.5], E 26.2 [23.7], sn 26.3 [28.0], uj 41.8 [39.2], lj 36.4 [38.9], gs 38.0 [—].

Head moderately large, its dorsal profile sloping straight to the blunt, high snout, the anterior profile of which is nearly vertical. Head width about 80% HL. Interorbital space broad, slightly convex in life, flattened in preservation; dorsal margin of orbit not entering dorsal profile. Mouth terminal, horizontal, snout not protruding beyond upper lip. Oral cleft reaching to below anterior margin of orbit, tip of maxilla extending to below mid-eye. Teeth shouldered and trilobed, middle lobe largest, tips not sharp; arranged in 12 [14] and 13 [14] irregular oblique rows in both jaws, 5-7 teeth in a row anteriorly; innermost teeth largest. No diastema present at junction of upper or lower jaws. Eye relatively large, about 24-26% HL. Nostril with distinct short tube. Circumoral pores rather small, round to oval. Chin pore pair normally spaced, interspace  $pm_1$ - $pm_1$  nearly equal to  $pm_1$ - $pm_2$ . Suprabranchial pores two, the second slightly raised. Gill opening of holotype above pectoral base, extending from level of upper margin of eye to or just in front of dorsalmost pectoral ray, damaged on both sides of paratype. Opercular flap very small, rounded.

Upper pectoral lobe rather short, not nearly reaching anal-fin origin; pectoral rays shortened ventrally to 25 [26]th

ray which is a little shorter than half of upper lobe length. Pectoral-fin notch shallow but distinct. Lower pectoral lobe of 9 rays, short, with free tips. Uppermost pectoral ray level with middle of suborbital space. Lowermost pectoral ray below anterior margin of orbit. Basal cartilaginous lamina of pectoral girdle narrow. Radials 4 (3+1), notched. Three interradian fenestrae present.

Body moderately elongated, greatest depth about equal to HL. Ventral disk very small, its length about one-half eye diameter; anterior lobe not developed; disk centre slightly depressed, surrounded by a very narrow, thin, delicate, smooth, upturned margin. Anus very close to (almost immediately behind) disk. Behind anus, a rounded area of thick, compact tissue present, surrounded by a low skin fold. Genital opening on anterior part of rounded area, a small (probably urinary) papilla immediately posterior to opening. Anterior dorsal rays shortened, not rudimentary. Interneural of first dorsal ray between fourth and fifth neural spines; one free (rayless) interneural present anteriorly. Three thin pleural ribs originate on parapophyses of 8th, 9th and 10th vertebrae, the last two longer, sabre-like, curved ventrally. Hypural plate single, with a trace of suture. Anal-fin origin below 12th vertebra. Caudal fin of 10 [11] rays, 9 principal, holotype with one small procurrent ray above (1+4/5) and paratype with one also below [1+4/5+1]. Posterior dorsal- and anal-fin rays apparently overlapping about one-third caudal-fin length. Skin thin, fragile, prickles absent. Gelatinous tissue moderately developed. Pyloric caeca thick, similar in size, length 5-6% SL, located right

ventrally to stomach and unusually far anterior relative to its fundus.

**Colour.** Body dull translucent brown; orobranchial cavity dusky, peritoneum black. Stomach pale, finely reticulated with black, appearing dusky.

**Distribution.** Off New South Wales at 1061–1134 m. *Careproctus paxtoni* is the only species of the genus known from Australia.

**Biology.** Both specimens are females with eggs close to being ripe, 3.7 and 3.3 mm diameter respectively, in addition to very small oocytes. The unusual postgenital area of thick, compact tissue with an associated skin fold in both specimens may be related to spawning and may thus be a temporary phenomenon. Its function is unknown.

**Etymology.** Named after John R. Paxton, formerly Principal Research Scientist in the fish collection at the Australian Museum, Sydney, in honour of his many contributions to knowledge of Australian and deep-sea fishes.

**Comparative notes.** *Careproctus paxtoni* belongs in *Careproctus* s. str. (see Andriashev, 1998) because it has 4 (3+1) notched pectoral radials, with three interradial fenestrae. This and other character states and its distribution place it in the *Careproctus* group around the Antarctic, including species from South Africa, Argentina, New Zealand, and the South Shetland Is. Of these species it is most similar to *C. novaezelandiae* Andriashev but differs in having two suprabranchial pores (v. one), blunt teeth, pale to dusky stomach (v. black), fewer pectoral rays (34–35 v. 37–38), unslit hypural plate (v. divided) and a smaller disk (3.0–3.1% v. 6.7% SL). In addition, postgenital morphology like that of *C. paxtoni* has not been described for any other species, although that may be a function of temporary existence only at spawning times or having been overlooked.

## Genus *Pseudnos* Barnard, 1927

Dwarf snailfishes

Figs. 15, 16

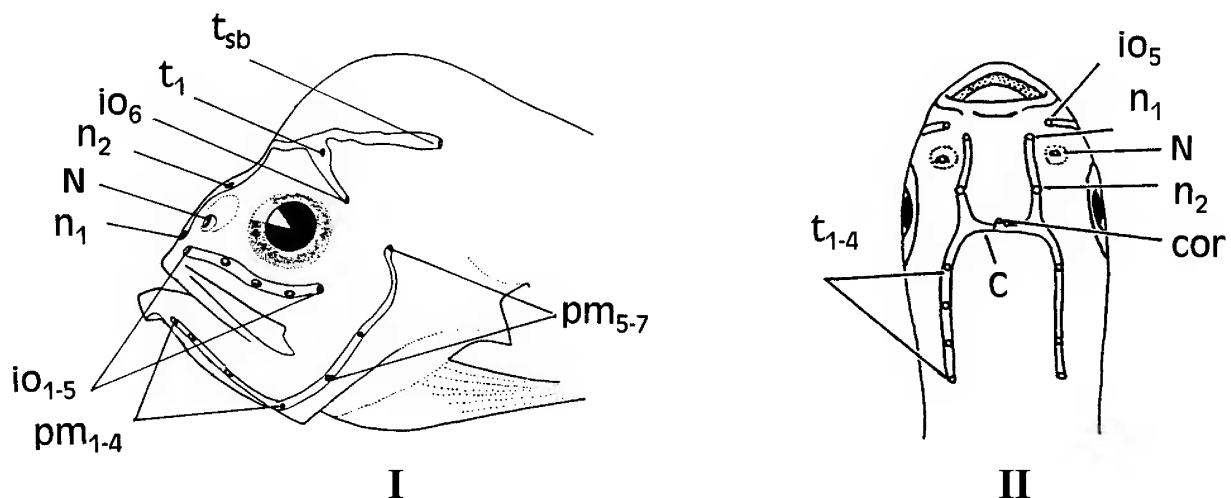
*Pseudnos* Barnard, 1927: 927 (type species *micurus* Barnard).–

Andriashev, 1992: 3 (redescription of the genus).

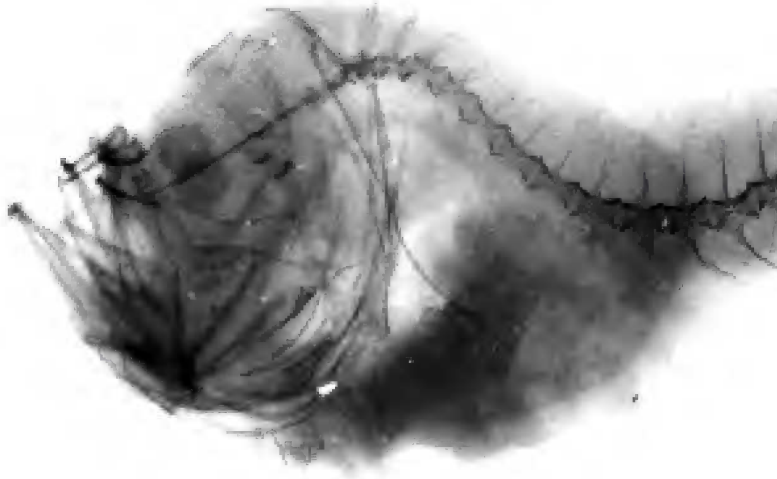
*Paraliparis* (non Collett) Stein, 1978a; 1986: 493.

**Diagnosis.** Ventral disk absent. No pseudobranchiae. One pair of nostrils. Mouth oblique, superior or terminal. Opercle very long. Infraorbital sensory canal (c.io) widely interrupted behind eye, consisting usually of six (5+1) or five (5+0) pores (Fig. 15). Nasal pores widely spaced, the upper nasal pore ( $n_2$ ) opening higher and behind vertical through nostril. Coronal commissure (C.) with or without a coronal pore (cor). Suprabranchial pore ( $t_{sb}$ ) very widely spaced from top of gill slit. Preoperculo-mandibular pores (pm) 6–7. Pectoral fin of 13–17 rays. Caudal fin usually of 6 rays. Pectoral girdle with 3 radials, rounded or notched. Interradial fenestrae present or absent. Vertebrae 41–58. Pleural ribs absent. Hypural plate single, unslit. Body distinctly hump-backed, high at occiput. Anterior abdominal vertebrae and base of cranium forming an arch at about 90° (Fig. 16). At least about 30 poorly known species from temperate and subtropical seas of Southern and Northern Hemispheres. Five or six species known from the northern part of the Southern Ocean. Probably mesopelagic or epibenthic.

**Comparative notes.** The genus *Pseudnos* differs from *Paraliparis* and other diskless genera of liparids in having a number of distinctive features: the morphology of the sensory canal system is unique in having nasal pores more dorsally located and the infraorbital canal interrupted behind the eye; the distinctly hump-backed body because of the sharply curved anterior of the vertebral column; and the pectoral girdle with 3 radials.



**Figure 15.** *Pseudnos*. Diagram of cephalic sensory canal system and pores. I, lateral view. II, dorsal view. C, coronal commissure; cor, coronal pore; io, infraorbital pores ( $io_6$  = supraorbital pore); n, nasal pore; N, nostril; pm, preoperculo-mandibular pores; t, temporal pores;  $t_{sb}$ , suprabranchial pore (=  $t_1$ ).



**Figure 16.** *Psednos micrurus*, holotype, BMNH 1930.1.14.7, ♀, 45 mm SL. Radiograph showing typical “hump-backed” vertebral column. Radiograph 17451.

#### Key to Southern Ocean *Psednos*

- 1 Vertebrae 42–43. Anal-fin rays 28–31. Pectoral radials 3, rounded, equidistant, unnotched. Interradial fenestrae absent ... *Psednos micrurus* Barnard (South Africa)
  - Vertebrae 56–58. Anal-fin rays more than 40. Pectoral radials 3, not equidistant (2+0+1), notched. One or more interradian fenestrae present ..... 2
- 2 Gill opening short, 24% HL, less than eye diameter, entirely above pectoral base. Eye 6.3% SL (27.6% HL) ..... *Psednos* sp.
  - Gill opening longer, 31–35% HL or 1.6–1.8 eye diameter, reaching ventrally in front of 2–5th pectoral ray. Eye 4.1–5.2% SL (19–21.2% HL) ..... 3
- 3 Peritoneum light brown, stomach dusky (not black). Tongue pale. Gill opening reaching ventrally to 2nd pectoral ray. Rays of lower pectoral-fin lobe shorter than those of upper pectoral-fin lobe ..... *Psednos balushkini* n.sp.
  - Peritoneum black, stomach black. Tongue black-dotted or dusky. Gill opening reaching to 4–5th pectoral ray. Rays of lower pectoral-fin lobe slightly longer than those of upper pectoral-fin lobe ..... 4
- 4 Opercular lobe very weakly developed, indistinct (Fig. 18). Depth of head at occiput about 133% HL. Pyloric caeca of different lengths, 5–9.5% SL. All gill arches dark-dotted ..... *Psednos nataliae* n.sp.
  - Opercular lobe small but distinct, prominent as an angle (Fig. 19). Depth of head at occiput about 106% HL. Pyloric caeca of similar lengths, 3.5–4.5% SL. Gill arches undotted ..... *Psednos whitleyi* n.sp.

#### *Psednos balushkini* n.sp.

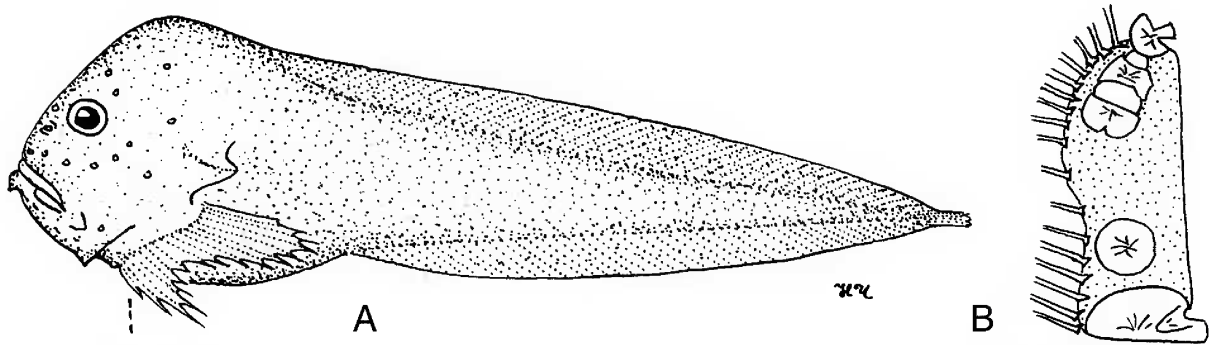
Fig. 17

**Material examined.** HOLOTYPE AMS I24860-002, ♂, 90 mm TL, 84 mm SL. FRV *Kapala*, fld. no. K 84-17-05, 34°48.5'S 151°15.5'E, E of Shoalhaven Heads, New South Wales, 914–960 m, 4 Oct. 1984; radiograph ZISP 20032; pectoral girdle 728. PARATYPE AMS I24059-018, ♂, 92 mm TL, 82 mm SL. FRV *Kapala*, Fld No. K 83-09-02, 33°32'S 152°09'E, off Norah Head, New South Wales, 942–978 m, 23 Aug. 1983; radiograph ZISP 20032; pectoral girdle 729.

**Diagnosis.** Vert. 57 (11–12+45–46), D 49–50, P 17 (9–10+1–2+6), C 6, radials 3 (2+0+1), notched with 2 fenestrae (f1, f2). Depth at occiput 111–123% HL. Gill opening extending ventrally in front of two pectoral rays. Opercular lobe small but distinct. Rays of lower pectoral-fin lobe shorter than in the upper. Pyloric caeca of similar length, c. 6% SL, slightly dotted at bases. Pores n 2, i.o. 5+1, t 1+1, cor. absent. Orobranchial cavity pale scarcely dotted, tongue pale, peritoneum light brown or paler. Gill arches not dotted.

**Further description.** Counts: D 49 [50], A 43 [43], P 17 [17], C 6 [6], Vert. 57 [57], radials 3 (2+0+1), two interradian





**Figure 17.** *Psednos balushkini* n.sp. A, holotype, AMS I24860-002, ♂, 90 mm TL, 84 mm SL. B, P 728, cleared and stained right pectoral girdle; fin rays reconstructed from left side.

fenestrae, gr 10 [9], pc 10 [8]. Ratios: HL 23.8 [24.4], its width 11.9 [12.2], depth at occiput 29.2 [27.1], bdA 18.1 [17.4], preD 31.0 [29.3], preA 37.5 [40.2], ma 17.9 [18.5], aAf 22.0 [22.0], UPL 15.5 [14.9], NL 6.0 [6.7], LPL 13.1 [12.1], io 10.7 [10.4], E 5.0 [5.2], sn 7.1 [8.5], uj 11.7 [12.1], gs 8.3 [torn]. In % HL: depth at occiput 123 [111], hd width 50 [50], UPL 65 [61], io 45 [42.5], E 21 [21], sn 30 [35], uj 49 [50], gs 35, pc 6.

Head high, its upper profile forming at occiput an angle of about  $100^\circ$  with rounded top. Depth at occiput 1.2 [1.1] HL, 1.6 [1.6] depth at anal-fin origin. Head width 0.41 [0.45] its depth. Area from upper lip to crest of occiput abrupt, distance between them equal to HL. Mouth superior, distinctly oblique, forming an angle of about  $40^\circ$  to the horizontal. Lower jaw projecting, with a tooth-like knob on outside of symphysis but absent inside. Tooth plates narrow, with 19–23 oblique rows, 5–6 teeth per row anteriorly. Narrow diastema present in upper jaw. Posterior end of lower jaw forming a distinct ventrally-directed angle. Nostril level with lower margin of eye, with slightly raised rim. Eye not large. Gill opening slightly oblique, originating below horizontal through eye centre, reaching ventrally in front of second pectoral-fin ray. Opercular lobe not large, but distinct with rounded tip. Infraorbital canal widely interrupted behind eye; infraorbital pores 6 (5+1), the last on a horizontal through upper margin of eye. Coronal pore absent. Upper nasal pore ( $n_2$ ) opening above and behind nostril. Preoperculo-mandibular pores six;  $pm_6$  on horizontal with pupil of eye. Postorbital pore ( $t_1$ ) situated high, above pore i.o.<sub>6</sub>. Suprabranchial pore single, opening well above and ahead of dorsal end of gill opening, at distance of about 55% HL from it. Chin pores normally spaced,  $pm_1$ – $pm_1$  about equal to  $pm_1$ – $pm_2$ .

Pectoral fin distinctly notched; upper pectoral lobe not quite reaching anal-fin origin, consisting of 10 [9] rays; notch ray single [2], 38% of upper lobe length. Lower pectoral lobe of 6 rays, slightly shorter than the upper one. Uppermost pectoral ray level with posterior end of mouth cleft. Basal cartilaginous lamina of pectoral girdle uniformly wide, with 3 (2+0+1) radials, two upper radials and scapula notched, including two rounded interradiial fenestrae (f1, f2).

Body distinctly hump-backed, dorsal outline sloping gently from high occiput caudally; depth at anal-fin origin 62.5% of depth at occiput. Angle of anterior four or five vertebrae with base of cranium a little less than  $90^\circ$ . Interneural of first dorsal ray between sixth and seventh

vertebrae (between fifth and sixth in paratype); one free (not bearing a ray) interneural present anteriorly. Trunk part of body rather large, more than  $\frac{2}{3}$  SL. Distance from mandibular symphyseal knob to anus less than interspace between anus and anal-fin origin. Hypural plate single, unslit. Caudal fin of 6 (3/3) rays. Skin thin, loose, subcutaneous gelatinous tissue well developed. Pyloric caeca about the same length and size. Small urogenital papilla present.

**Colour.** Skin white. Orobranchial cavity pale, partially with small sparse dots. Tongue pale anteriorly, with small sparsely scattered dots centrally. Gill arches undotted. Peritoneum light brown (lighter in paratype). Stomach dusky with reticulated pattern of melanophores extending over anterior part of intestine, resembling network of black blood vessels. Pyloric caeca pale, sparsely dotted at bases.

**Distribution.** Off New South Wales at 914–978 m.

**Etymology.** The new species is named after Dr Arkady V. Balushkin of the Zoological Institute, Russian Academy of Sciences, St. Petersburg, in honour of his many contributions to the knowledge of Antarctic fishes, especially to the taxonomy of the suborder Notothenioidei.

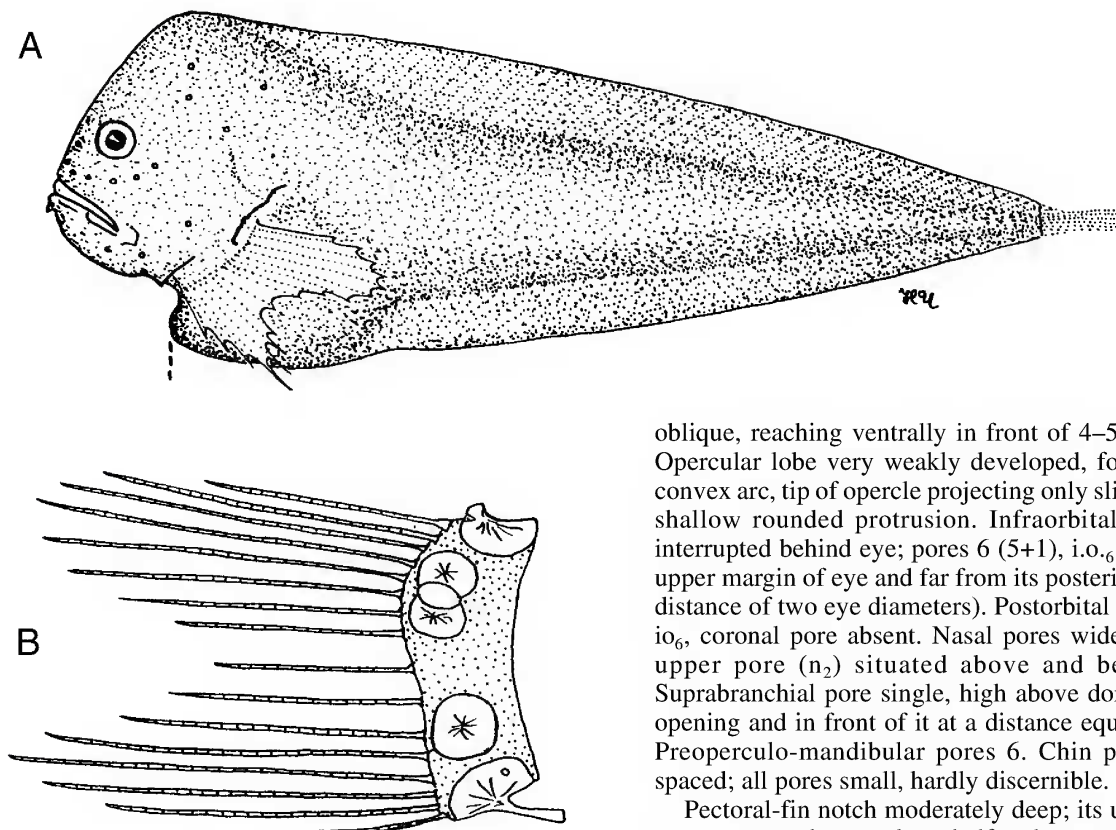
**Comparative notes.** *Psednos balushkini* differs from other Australian species of the genus *Psednos* in having a pale orobranchial cavity (v. dark or dotted) and a light brown peritoneum (v. black). For more detailed descriptions of differences, see descriptions of *P. nataliae* and *P. whitleyi*.

### *Psednos nataliae* n.sp. Stein & Andriashev

Fig. 18

**Material examined.** HOLOTYPE CSIRO H2636-04, ♂, unknown TL, 98.5 mm SL. FRV *Soela*, stn. So 2/89/80,  $42^\circ 16'S$   $144^\circ 39'E$ , SW of Cape Sorell, Tasmania, 1100–1120 m, 18 Mar. 1989; radiograph 20174; pectoral girdle 730.

**Diagnosis.** Vert. 58 (12+46), D 50, P 16 (8+2+6), radials 3 (2+0+1), notched with single fenestra (f2). Depth of occiput 133% HL. Gill opening extending ventrally in front of about fourth to fifth pectoral-fin rays. Opercular lobe very weakly developed, hardly discernible. Lower pectoral-fin rays 110% upper lobe rays. Pores n 2, i.o. 5+1, pm 6, t 1+1, cor.



**Figure 18.** *Pseudonatalia nataliae* n.sp. A, holotype, CSIRO H2636-04, ♂, unknown TL, 98.5 mm SL. B, P 730, cleared and stained right pectoral girdle.

absent. Tongue densely black-dotted. Orobranchial cavity dark, closely dotted with melanophores, as are gill arches. Peritoneum, stomach, and anterior part of intestine black. Pyloric caeca different lengths, 5–9.5% SL, all dark-dotted.

**Further description.** Counts: D 50, A 42, P 16, C missing, Vert. 58, radials 3, fenestra single (f2), gr 9, pc 7. Ratios: HL 21.3, its width 10.2, depth at occiput 28.4, bdA 21.3, preD 28.9, preA 35.5, ma 17.3, aAf 21.3, UPL 14.7, NL 7.6, LPL 16.2, io 9.1, E 4.1, sn 7.1, uj 11.4, gs 7.3, pc 5–9.5. As percentage HL: depth of head 133, UPL 69, LPL 76, io 43, E 19.0, sn 33.3, uj 53, gs 34.5.

Dorsal profile of snout and head rising very steeply at an angle of 70–80°, forming at occiput a high hump forming an included angle of about 90°, with broadly rounded top. Head short, compressed, its width 36% of head depth; the latter exceeds 130% HL. Abrupt distance between upper lip and top of occiput about equal to HL. Mouth superior, very oblique, angle of 40–45° to a horizontal midline. Interorbital space relatively broad, slightly convex. Symphyseal knob present. Teeth simple, small, slender, sharp canines, in each jaw forming a narrow band of 20 and 17 irregular oblique rows, uniserial posteriorly, of 5–6 teeth in each anterior row. Wide diastema present at premaxillary joint. Teeth in lower jaw similar, diastema absent. Posteroventral corner of lower jaw forming an angle protruding ventrally below lower outline of head. Eye relatively small; dorsal margin of orbit near profile of head but not entering into it. Nostril damaged. Gill opening origin slightly below horizontal through ventral margin of eye,

oblique, reaching ventrally in front of 4–5 pectoral rays. Opercular lobe very weakly developed, forming a broad convex arc, tip of opercle projecting only slightly to form a shallow rounded protrusion. Infraorbital canal widely interrupted behind eye; pores 6 (5+1), i.o.<sub>6</sub> above level of upper margin of eye and far from its posterior margin (at a distance of two eye diameters). Postorbital pore (t<sub>1</sub>) above io<sub>6</sub>, coronal pore absent. Nasal pores widely spaced, the upper pore (n<sub>2</sub>) situated above and behind nostril. Suprabranchial pore single, high above dorsal end of gill opening and in front of it at a distance equal to 50% HL. Preoperculo-mandibular pores 6. Chin pores regularly spaced; all pores small, hardly discernible.

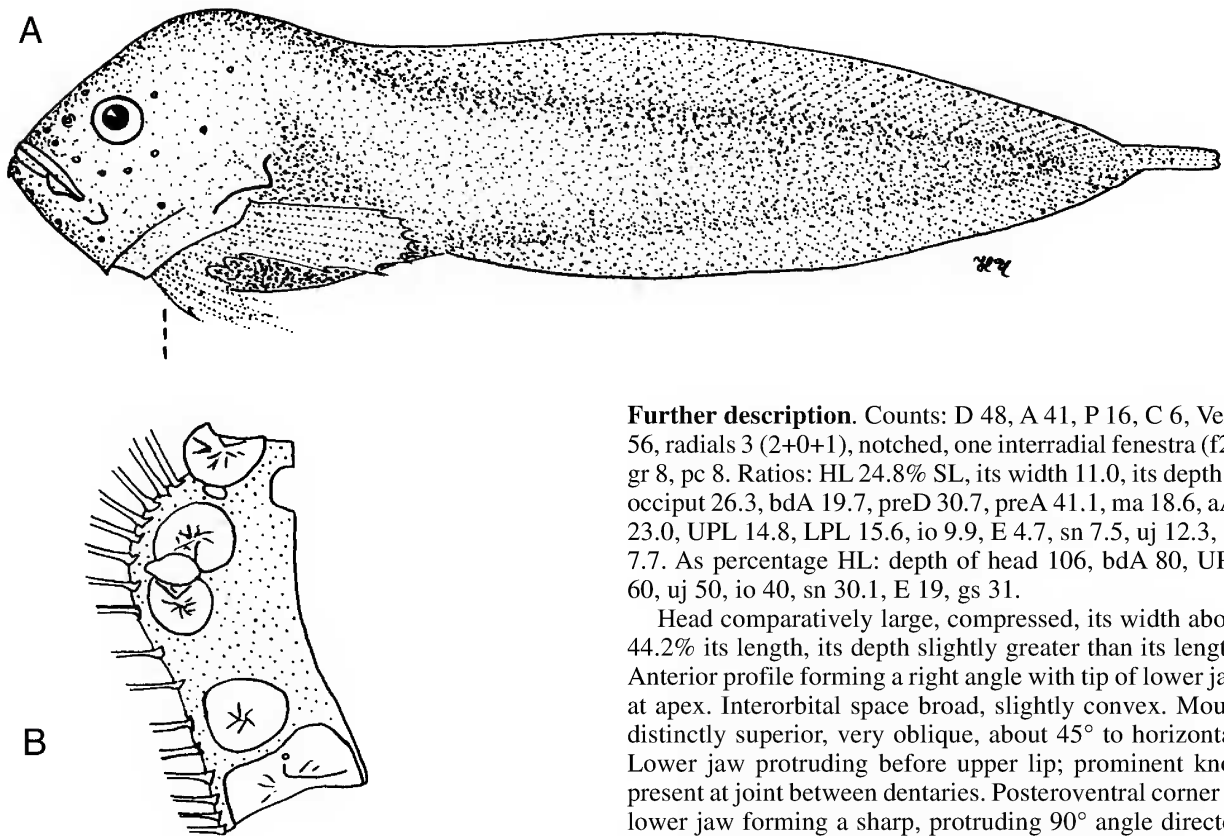
Pectoral-fin notch moderately deep; its upper lobe of 8 rays; two notch rays about half as long as upper pectoral lobe. Lower lobe of 6 rays, a little longer than upper lobe rays. Basal cartilaginous lamina of pectoral girdle uniformly wide, with 3 (2+0+1) radials, two upper notched and including one oval fenestrae (f2). Lowermost radial largest. Scapula unnotched, with very small helve. Coracoid with elongated helve and small opening.

Body strongly hump-backed, dorsal outline rising abruptly to prominent hump and tapering rapidly posterior to it to a point above end of abdominal cavity, then evenly to caudal. Depth of occiput 140% depth at anal-fin origin. Vertebral column strongly curved, forming nearly right angle with base of skull. Interneural of first dorsal-fin ray between sixth and seventh neural spines; one free (rayless) interneural present anteriorly between 5th and 6th neural spines. Trunk not large, slightly more than 33% SL. Distance from mandible to anus 83.3% of distance between anus and anal-fin origin. Caudal fin unknown; hypural plate and all rays missing. Skin thin, naked, loose. Subcutaneous gelatinous tissue obviously well developed.

**Colour.** Body white. Pale tongue with strongly contrasting black dots. Orobranchial cavity dark, closely dotted with melanophores. Peritoneum, stomach and anterior part of intestine black. Pyloric caeca and all gill arches dark-dotted.

**Distribution and biology.** West coast of Tasmania at 1100–1120 m. The specimen is an adult male with ripe testes and a long tubular urogenital papilla. The anus and genital area, with the adjoining part of the belly, are directed ventrally and forward in spawning condition.

**Etymology.** The new species is named after Dr Natalia V. Chernova, Zoological Institute, Russian Academy of Sciences, St. Petersburg, in honour of her contributions to knowledge of Arctic liparids and other fishes.



**Figure 19.** *Psednos whiteleyi* n.sp. A, holotype, CSIRO H1335-02, ♂, 105.4 mm TL, 91.2 mm SL. B, P 727, cleared and stained right pectoral girdle.

**Comparative notes.** *Psednos nataliae* n.sp. differs from the other two known species of Australian *Psednos* in having a weakly developed opercular lobe and dark-dotted gill arches. Furthermore, it differs from *P. balushkini* in having a black peritoneum (v. light brown), a dark orobranchial cavity (v. pale, scarcely dotted) and a lower pectoral-fin lobe slightly longer than the upper. It differs from *P. whiteleyi* by its very high occiput (133% HL v. 106%).

***Psednos whiteleyi* n.sp.**

Fig. 19

**Material examined.** HOLOTYPE CSIRO H1335-02, ♂, 105.4 mm TL, 91.2 mm SL. FRV *Soela*, stn. So 3/86/28, 41°18.4'S 144°05'E, NW of Kenneth Bay, Tasmania, 900–920 m, 14 May 1986; radiograph 20173; pectoral girdle 727.

**Diagnosis.** Vert. 56 (11+45), D 48, P 16 (8+2+6), C 6, radials 3 (2+0+1), two upper radials notched, a large fenestra (f2) between them. Depth at occiput 106% HL. Gill opening extending ventrally in front of 4–5 pectoral-fin rays. Opercular lobe small but distinct, protruding as a right angle. Tongue light dusky. Orobranchial cavity dusky, black-dotted. Peritoneum and stomach black, anterior part of intestine dark brown to black. Pyloric caeca short, similar in length, 3.5–4.5% SL, all dark-dotted. Gill arches without melanophores. Pores n 2, i.o. 5+1, pm 6, t 0+1, cor. absent.

**Further description.** Counts: D 48, A 41, P 16, C 6, Vert. 56, radials 3 (2+0+1), notched, one interradial fenestra (f2), gr 8, pc 8. Ratios: HL 24.8% SL, its width 11.0, its depth at occiput 26.3, bdA 19.7, preD 30.7, preA 41.1, ma 18.6, aAf 23.0, UPL 14.8, LPL 15.6, io 9.9, E 4.7, sn 7.5, uj 12.3, gs 7.7. As percentage HL: depth of head 106, bdA 80, UPL 60, uj 50, io 40, sn 30.1, E 19, gs 31.

Head comparatively large, compressed, its width about 44.2% its length, its depth slightly greater than its length. Anterior profile forming a right angle with tip of lower jaw at apex. Interorbital space broad, slightly convex. Mouth distinctly superior, very oblique, about 45° to horizontal. Lower jaw protruding before upper lip; prominent knob present at joint between dentaries. Posteroventral corner of lower jaw forming a sharp, protruding 90° angle directed below centre of eye. Teeth small, slender canines arranged in about 26 and 21 irregular oblique rows in jaws forming narrow bands 5–6 teeth per row anteriorly. Wide diastema in premaxilla; almost no dentary diastema. Eye moderately small, dorsal margin of orbit well below dorsal outline of head; pupil about half eye. Gill opening distinctly oblique, slightly exceeding eye, reaching ventrally in front of 4–5 pectoral-fin rays, its dorsal end about level with lower margin of eye. Opercular lobe not large, well developed in upper part of gill opening as nearly right angle; supported dorsally by narrow, sharply pointed opercle which is noticeably curved ventrally. Infraorbital canal widely interrupted behind eye, of 6 pores (5+1). Nasal pores widely spaced, second pore (n<sub>2</sub>) opening high above and behind vertical through nostril. Small tube present in place of coronal pore; pore itself not discernible. Supraorbital pore single, high above and anterior to upper end of gill opening, at a distance equal to 38% HL. Postorbital pore (t) not found owing to damaged skin.

Preoperculo-mandibular pores 6, anterior pair normally spaced.

Level of uppermost pectoral-fin ray below orbit, about even with tip of suborbital stay, midway between orbit and posterior of maxilla. Pectoral-fin base angled forward ventrally. Fin divided into two lobes by moderately deep notch; rudimentary rays absent. Upper lobe of 8 rays not reaching anal-fin origin. Two notch rays present; lower lobe slightly longer than upper. Basal cartilaginous lamina short and wide, with three (2+0+1) radials, the two uppermost notched with an oval fenestra between them (f2). Scapula unnotched, one rudimentary fenestra (f1) present ventrally.

Body moderately hump-backed, depth at occiput 133% depth at origin of anal fin. Maximum depth at occiput about on vertical through lower end of gill slit. Trunk tapering evenly behind abdominal cavity to caudal fin. Interneural

of first dorsal-fin ray between 5th and 6th neural spines. Caudal fin of 6 (3/3) rays, overlapped about 40% by dorsal- and anal-fin rays. Skin very thin, fragile, easily torn; holotype partly skinned. Pyloric caeca all of similar length, 3.5–4.5% SL.

**Colour.** Body white except for dark abdominal cavity showing through wall. Tongue light dusky. Orobranchial cavity, tongue and pyloric caeca dotted with small melanophores. Gill arches not dotted. Peritoneum and stomach black, anterior part of intestine dark brown to black.

**Distribution.** Off NW Tasmania between 900 and 920 m depth.

**Etymology.** The new species is named in honour of Gilbert P. Whitley (1903–1975), well known Australian ichthyologist, formerly Curator of the fish collection in the Australian Museum, Sydney.

**Comparative notes.** *Pseudnos whitleyi* n.sp. is similar to *P. nataliae* in having a black peritoneum and stomach and the lower pectoral-fin lobe slightly longer than the upper one. It differs in the lower hump (depth at occiput 106% HL v. 133%), shorter pyloric caeca (3.5–4.5% SL v. 5–9.5%), undotted gill arches (v. dark-dotted in *P. nataliae*) and the well-developed angulate opercular lobe.

#### *Pseudnos* sp.

**Material examined.** AMS I24980-003 (dried), unknown sex and TL, 63 mm SL. FRV *Kapala*, fld. no. K84-16-15, 33°43.5'S 152° 00.5'E, off Sydney, New South Wales, 960–998 m, 27 Sep. 1984.

**Description.** Vert. 57 (11+46), interneural of the 1st dorsal ray fits between 6th and 7th neural spines, 1 free interneural present anteriorly between 5th and 6th neural spines. P 16 (9+1+6). Ratios: HL 23, its width 11.1 (48), depth at occiput c. 26.2 (114), E 6.3 (27.6), uj 12.7 (55), gs 5.5 (24.1). Coronal pore absent. Teeth in 17 and 20 irregular rows, uniserial posteriorly, about 5 teeth in a row near symphysis. Opercular lobe distinct. Gill opening less than eye (0.8 eye) and entirely above pectoral base.

**Colour.** Body light, peritoneum black. Orobranchial cavity and tongue light.

**Comparative notes.** Differs from all other Australian *Pseudnos* in the large eye (6.3 v. 4.1–5.2% SL and 27.6 v. 19–21% HL) and short gill opening (24 v. 31–35% HL) less than eye (0.8 v. 1.6–1.8 eye) and entirely above the pectoral base (v. reaching ventrally to 2nd–5th pectoral rays). Because of its poor condition and our inability to provide a complete description, we do not name this species.

#### Genus *Paraliparis* Collett, 1878

*Paraliparis* Collett, 1878: 34 (type species *Paraliparis bathybi* Collett, 1878 by monotypy). Burke, 1930: 154; Andriashev, 1954: 464; Cohen, 1968: 385; Stein, 1978a: 5, 1978b: 37; Andriashev, 1986: 14.

**Diagnosis.** One pair of nostrils (nostrils single). Ventral sucking disk absent. A single terminal (sensu Andriashev, 1986) or suprabranchial (sensu Burke, 1930) pore present in temporal canal. Pectoral fin divided into two lobes or not; if present, lower lobe not forming a single filament. Pseudobranch absent. Coronal pore absent. Barbels or skin flaps on head absent.

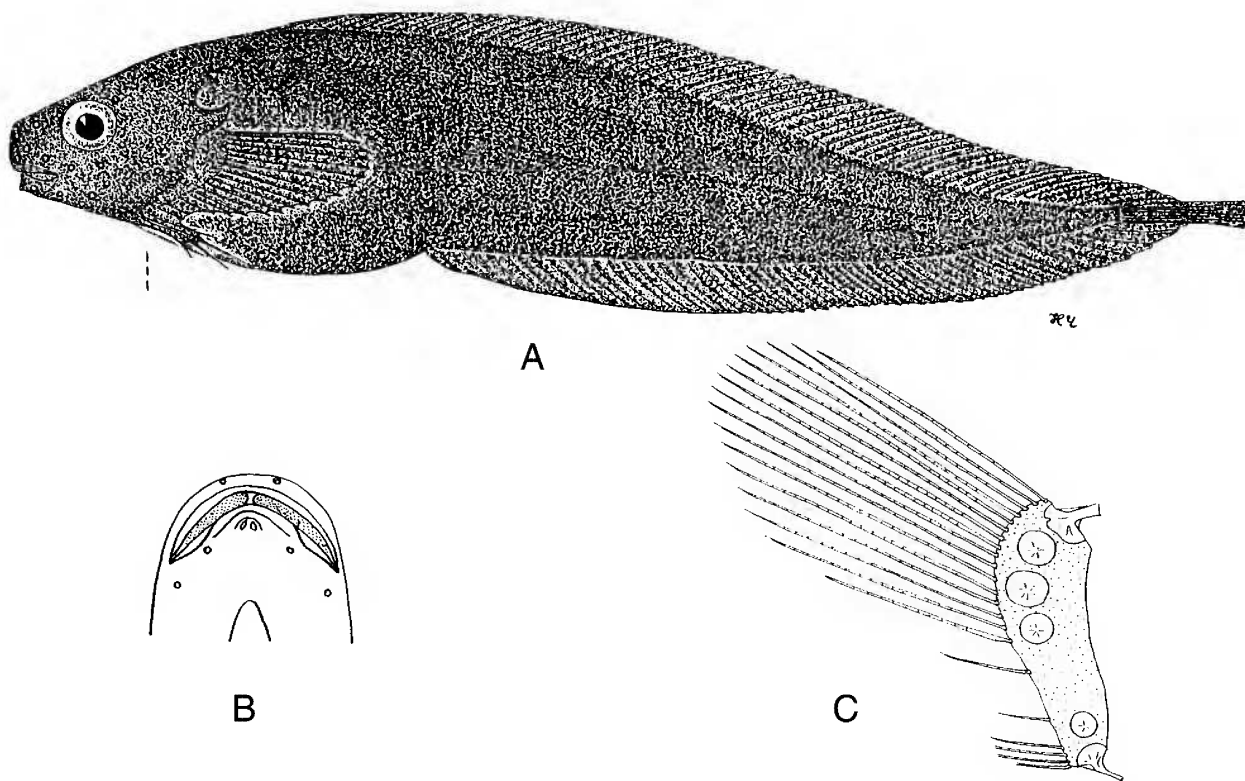
#### Key to Australian *Paraliparis*

- 1 Chin pore one (Fig. 8-IV) ..... *Paraliparis impariporus*
- Chin pores two (Fig. 8-I, II, III) ..... 2
- 2 Mouth oblique, symphysis of upper jaw level with lower margin of eye (Fig. 5-I) ..... 3
- Mouth horizontal, symphysis of upper jaw below eye level (Fig. 5-II) ..... 5
- 3 Lower jaw projecting (Fig. 6-V). Body ink-black, skin dense, not transparent. Secondary caudal rays present, C 1+3/3+1 ..... *P. eastmani*
- Lower jaw included (Fig. 6-IV). Body nut-brown or reddish-brown, skin thin and semitransparent. Secondary caudal rays absent, C 4/4 ..... 4
- 4 Teeth tiny, tooth plates look smooth; diastemae absent. Eye close to dorsal contour of head. Body uniform nut-brown. Lips, subrostral fold inside, and chin same colour as head. D 58, first dorsal-ray interneural between neural spines 5 and 6. Radials 3+0, fenestrae in cartilaginous basal lamina absent. Pectoral fin short, 60.5% HL ..... *P. avellaneus*
- Teeth normal, quite large; diastemae present. Eye far below dorsal contour of head. Body reddish-brown, caudal darker. Lips and

- chin blackish, subrostral fold inside brightly black-dotted. D 62, first dorsal-ray interneural between neural spines 3 and 4. Radials 2+0, fenestrae two. Pectoral fin long, 75% HL ..... *P. brunneocaudatus*
- 5 Mouth inferior (Fig. 5-IIC). Gill opening dorsally located, ventral end level with upper margin of pupil or above (Fig. 26 or 43) ..... 6
- Mouth terminal or subterminal (Fig. 5-IIA,B). Gill opening more ventrally located, ventral end level with eye centre or below ..... 7
- 6 Body very dark brownish-black, tooth plates dark grey. Subrostral fold present, very deep, entirely covering upper lip (Fig. 3-II). Lower jaw subterminal. Teeth tiny, tooth plates look smooth. Pores distinctly contoured. Eye 23% HL, gill opening almost equal to eye ..... *P. plagiosomus*
- Body colour brown, tooth plates pale. Subrostral fold absent, upper lip entirely visible (Fig. 3-I). Lower jaw included. Teeth normal, prominent. Pores not contoured. Eye large, 29% HL. Gill opening half of eye ..... *P. badius*
- 7 Chin pores without common skin fold anteriorly (Fig. 8-I, III, II *obtusirostris* only) ..... 15
- Chin pores with common skin fold anteriorly (Fig. 8-II). (Teeth small. Colour light to dark brown or black) ..... 8
- 8 Eye 27% HL. Gill opening reaching to pectoral ray 4. Pectoral notch rays rudimentary, P 16/17+2r+3 (Fig. 29). Radials 3+1, lowermost radial half-moon shaped, at posterior margin of cartilaginous basal lamina (subrostral fold absent. Body jet-black. Anus below rear of postorbital space) ..... *P. coracinus*
- Eye 21–25% HL. Gill opening usually entirely above base of pectoral fin, only in *P. anthracinus* reaching to second pectoral ray (Fig. 20). Pectoral notch rays not rudimentary, P 15/18+1/2+3/4, radials 2–4, all round ..... 9
- 9 Opercular lobe ear-shaped (Fig. 10-IVB). Snout abruptly angled, almost absent in lateral view (Fig. 2-IF). Anterior 4 dorsal rays short. Anus far posterior, below gill opening ..... *P. auriculatus*
- Opercular flap of other shape (except in *P. labiatus*). Snout normal, well developed. Anteriormost dorsal rays usually not short, if so, not more than 2. Anus below first or second third of postorbital space (except *P. ater*, *P. labiatus*) ..... 10
- 10 Subrostral fold entirely absent. Gill opening reaching ventrally in front of second pectoral ray. Lower jaw included. Body elliptic, deep (Fig. 13-II). Opercular flap sharp-tipped, dorsally notched (Fig. 10-IB) ..... *P. anthracinus*
- Subrostral fold present, usually deep (if shallow, lower jaw subterminal, nephrohaemal canal present and radials 3+0 or 2+0 *P. ater* and *P. atrolabiatus*). Gill opening above or reaching ventrally in front of uppermost pectoral ray. Body elliptic, low or ventrally straight. Opercular flap of other shape ..... 11
- 11 Opercular flap small, triangular, covering lower half of gill opening (Fig. 10-IIIA). Mouth short, reaching to below anterior margin of eye. First dorsal-ray interneural between neural spines 3 and 4, free interneurals absent. Radials 3+0, round. (Fenestrae absent. Uniformly black, including lips) ..... *P. ater*
- Opercular flap larger, rounded, covering upper half of gill opening. Mouth short or longer, reaching to below pupil. First dorsal-ray interneural posterior to neural spine 4 (4/5 to 6/7), free interneurals present. Radials 2 or 4 ..... 12

- 12 Eye not large, 21% HL. Opercular flap ear-shaped (Fig. 10-IVB). Chin margin right-angled, with sharp firm edge (Fig. 9-II). Radials 3+1, round; fenestrae absent. Snout deep, bluntly rounded (Fig. 2-IC). (Lip wide) ..... *P. labiatus*
- Eye larger, 23–24% HL. Opercular flap of other shape. Chin slanted or with rounded edge (Fig. 9-I or 9-III). Radials 2 or, if 4, notched, 3 fenestrae present. Snout not blunt, rounded ..... 13
- 13 Body light brown, head much paler, yellowish, lips distinctly darker, blackish. First dorsal ray interneural between neural spines 6 and 7. Anus below first third of postorbital space. Snout shallow, rounded, projecting (Fig. 2-IE) ..... *P. atrolabiatus*
- Head and body colour uniform dark. First dorsal ray interneural between neural spines 4 and 5 or 5 and 6. Anus below second third of postorbital space. Snout deep (Fig. 2-IG or I) ..... 14
- 14 Body elliptic, low, not humpbacked (Fig. 13-I). Anterior 2 dorsal rays short. Anus below second third of postorbital space. Nephrohaemal canal absent. P 18+1+4, radials 4 (3+1), notched, 3 fenestrae present. Chin pore interspace 1 pore diameter, unpigmented. Eye nearly touching dorsal contour of head. Lips paler than head ..... *P. brunneus*
- Body ventrally straight, humpbacked (Fig. 13-V). Anterior dorsal rays not short. Anus below middle of postorbital space. Nephrohaemal canal on vertebrae 5–11. P 15+2+4, radials 2+0, round, fenestrae absent. Chin pores almost touching, interspace unpigmented. Eye far below dorsal contour of head. Lips as dark as head ..... *P. delphis*
- 15 Chin pores not in a common depression (Fig. 8-I) ..... 23
- Chin pores in a common shallow oval depression (Fig. 8-II, IIIA,B) ..... 16
- 16 Pectoral notch rays one or two, not rudimentary, about  $\frac{1}{4}$ – $\frac{1}{3}$  upper lobe length ..... 17
- Pectoral notch rays absent (P 16+0+4), or rudimentary (15+1r+4 =3+1r) and visible only in preparations ..... 18
- 17 Prominent costal ridge present on each side of body above anterior half of pectoral fin. Chin pore interspace pigmented. Opercular flap triangular, with equal sides (Fig. 10-IA), covering gill opening entirely ..... 22
- Costal ridge weak or absent. Chin pore interspace unpigmented with exception of *P. gomoni*. Opercular flap not as above (Fig. 10-IB, IIA,B,C) (Parapophyses of posterior abdominal vertebrae not joined) ..... 19
- 18 Chin pore pit on lower surface of chin (Fig. 9-III). Subrostral fold present. Eye close to dorsal contour of head. Lips as dark as head. Nephrohaemal canal absent. P. 16+0+4 ..... *P. australiensis*
- Chin pore pit on anterior surface of chin (Fig. 9-IVA). Subrostral fold absent. Eye well below dorsal contour of head. Lips paler than head. Nephrohaemal canal present. P. 15+1r+4 ..... *P. csiroi*
- 19 C 9 (1+4/4). Lower jaw subterminal. Radials 2+0. Body ventrally straight, leaf-like (Fig. 13-VII). (Mouth reaching to below anterior half of pupil. P 14+2/3+3/4. Anterior two dorsal rays short. Snout deep, blunt. Mouth terminal) ..... *P. obtusirostris*
- C 8 (4/4). Lower jaw included or almost included. Radials 3+0. Body of other shape (Fig. 13-I, III) ..... 20

- 20 Mouth terminal. Chin margin vertical, right-angled (Fig. 9-II), honeycomb tissue on chin absent. Snout deep, blunt (Fig. 2-IA). Chin pore interspace pigmented. Opercular flap rounded ventrally (Fig. 10-IIB). Radials unnotched, round, fenestrae absent ..... *P. gomoni*
- Mouth subterminal. Chin margin slanted or rounded, honeycomb tissue on chin present. Snout rounded (Fig. 2-IB,E). Chin pore interspace unpigmented. Opercular flap sharp-tipped (Fig. 10-IB, IIC). Radials notched, fenestrae present ..... 21
- 21 Upper pectoral-fin lobe rays 17. Body hump-backed. Mouth cleft reaching to below anterior margin of eye. Subrostral fold present, anus below first third of postorbital distance ..... *P. infeliciter*
- Upper pectoral-fin lobe rays 14/15. Body straight-backed, ventral contour much more curved than dorsal. Mouth cleft reaching to below anterior margin of pupil. Subrostral fold absent, anus almost below gill opening ..... *Paraliparis* sp. 1
- 22 Chin pore interspace equals 2 pore diameters. Oral cleft reaching to below pupil. Anterior 3 dorsal rays not short. Head 21.4% SL. Pyloric caeca grey. Radials 4 (3+1). Subrostral fold present. Lower jaw included. Body ventrally straight, hump-backed ..... *P. dewitti*
- Chin pore interspace equals 1 pore diameter. Oral cleft reaching to below anterior margin of eye. Anterior 3 dorsal rays short. Head small, 17.7% SL. Pyloric caeca pale. Radials 2+0. Subrostral fold absent. Lower jaw subterminal. Body elliptic, low ..... *Paraliparis* sp. 2
- 23 Subrostral fold absent. Radials 2+0. Opercular flap covers lower  $\frac{2}{3}$  of gill opening, rounded (Fig. 10-IIA). Preoperculo-mandibular sensory pore series unusually close to infraorbital series,  $pm_7$  close to eye (distance c.  $\frac{1}{3}$  postorbital space). (Colour brown, with whitish blotches but without reddish tint) ..... *P. hobarti*
- Subrostral fold present. Radials 3 or 4. Opercular flap of other shape (Fig. 10-IIC, IIIA,B, IVA). Preoperculo-mandibular sensory pore series not close to infraorbital series, pore  $pm_7$  normally located (distance c.  $\frac{1}{2}$  postorbital space) ..... 24
- 24 Body reddish-brown. Teeth large, stout. Opercular flap small, triangular, covering lower half of gill opening (Fig. 10-IIIA). (Radials 3+0. Lower jaw included) ..... *P. lasti*
- Body black or dark blackish-brown. Teeth tiny or large (*P. retrodorsalis*). Opercular flap not as above. (Radials 3 or 4) ..... 25
- 25 Pectoral notch ray single, rudimentary, two or more pectoral girdle fenestrae present (Fig. 45) ..... *P. tasmaniensis*
- Pectoral notch rays two or more, not rudimentary, fenestrae absent ..... 26
- 26 Lower jaw included. Tooth plates dark. Mouth cleft reaching to below eye centre. Snout acutely angled. Opercular flap as in Fig. 10-IIC ..... *P. retrodorsalis*
- Lower jaw subterminal. Tooth plates pale. Mouth cleft reaching to below anterior margin of eye. Snout deep, blunt, vertical. Opercular flap as in Fig. 10-IIIB or IVA ..... 27
- 27 D 62–66. Costal keels distinct. Procurrent caudal rays present, C 1+3/3+1. Radials 3+1. Opercular flap covers lower half of gill opening (Fig. 10-IIIB). Chin slanted ..... *P. costatus*
- D 59. Costal keels absent. Procurrent caudal rays absent, C 4/4. Radials 3+0. Opercular flap dorsally rounded (Fig. 10-IVA). Chin right-angled (Fig. 9-II) ..... *P. piceus*



**Figure 20.** *Paraliparis anthracinus* n.sp. A, holotype, CSIRO H1576-02, ripe ♀, 150 mm TL, 133 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 793, cleared and stained right pectoral girdle.

*Paraliparis anthracinus* n.sp.

Fig. 20

**Material examined.** HOLOTYPE CSIRO H1576-02, ripe ♀, 150 mm TL, 133 mm SL. FRV *Soela*, stn. So 3/86/27, 41°46.4'S 144°24.4'E, W coast of Tasmania, W of Granville Harbour, 1024–1080 m, 14 May 1986; radiograph 680 D; pectoral girdle 793.

**Diagnosis.** Vert. 68, D 60, C 8, radials 4, rounded. Snout short, 27.8% HL. Mouth horizontal, subterminal, lower jaw included. Subrostral fold absent. Teeth simple, small. Chin pores with common skin fold anteriorly, located in a small depression undefined posteriorly. Ventral end of gill opening reaching in front of 2nd pectoral ray, dorsal pectoral ray level with eye centre. P 16+2+4, rudimentary notch rays absent. Distance from chin to anus long, 15% SL. Anus below second third of postorbital space. Head 20.3% SL, preanal distance large, 38%. Body black, peritoneum black.

**Further description.** Counts: D 60, A 55, P 22, C 8 (4/4), Vert. 68 (11+57), radials 4 (3+1), fenestrae absent, gr 8, pc 6, pores 2-6-7-1. Ratios: HL 20.3, its width 12.9 (59), and depth 17.3 (85), bd 21.8 (107), bdA 18.8 (93), preD 25.6, preA 38.3, ma 15.0, aAf 22.6, UPL 13.2 (65), LPL —, NL —, E c. 5.1 (25.0), gs 4.1 (20.0), sn 5.6 (27.8), po 10.5 (52), io 8.3 (40.7), so 3.8 (18.5), uj 8.3 (41.4), lj 8.6 (42.5), pc 6.2.

Head not small, 4.9 in SL, dorsal profile evenly sloping anteriorly to deep snout. Head depth 1.4 its width. Eye quite large, 4 in head, not touching dorsal contour of head; suborbital distance long, 0.7 eye; pupil  $\frac{2}{3}$  eye. Interorbital space 1.6 eye. Snout short, deep, bluntly rounded, 1.1 eye,

slightly projecting anterior to upper jaw, its highest point level with upper margin of pupil. Subrostral fold absent. Nostril level with mid eye. Mouth horizontal, subterminal, cleft reaching to below anterior fourth of eye; lower jaw included. Teeth simple, small, slightly prominent, 26 rows in upper jaw, anteriorly 11–12 teeth in length. Lower tooth plates damaged. Diastema of upper jaw narrow, absent in lower jaw. Chin right angled, lower jaw below posterior of oral cleft deep. Circumoral pores with thickened rims; chin pore interspace equal to pore diameter, pigmented, common anterior skin fold present with pores in a shallow depression undefined posteriorly. Gill opening short, 0.8 eye, ventral end level with eye centre, reaching in front of 2nd pectoral ray. Opercular flap triangular, dorsally notched, sharp tip level with upper margin of eye.

Uppermost pectoral ray level with mid-pupil. Pectoral rays broken, fin membrane missing. P 16+2+4, rudimentary rays absent. Radials 3+1, round, of similar sizes. Fenestrae absent. Coracoid helve thin, comparatively short.

Body deep, deepest between dorsal and anal-fin origins, 4.6 in SL; dorsal contour broadly rounded anteriorly and posteriorly from this point. General body shape elliptic, dorsal and ventral contours similar. Horizontal midline touching lower margin of eye. Preanal length large, 38% SL. First dorsal ray interneural between neural spines 5 and 6, two free anterior interneurals present. Anterior dorsal rays embedded in gelatinous tissue. Parapophyses of vertebra 11 joined together, forming short haemal spine. Costal ridges absent. Epineural ribs on vertebrae 2–13, epipleural ribs on 3–23, anterior ribs of both series not long, shorter than 3 vertebrae. Anus below second third of postorbital space. Vertical fins overlap about half of caudal fin. Skin opaque, prickles absent. Gelatinous tissue moderately developed.



Genital papilla absent. Ovarian eggs up to 3.5 mm. Pyloric caeca sharply pointed.

**Colour.** Head and body, lips, subrostral fold and chin uniformly black. Mouth grey, tongue slightly lighter, grey-dotted, tooth plates pale. Branchial cavity black, gill arches dark grey. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** West coast of Tasmania, 1024–1080 m.

**Etymology.** *Anthracinus* from the Latin, coal-coloured.

**Comparative notes.** A member of group IIIc, *P. anthracinus* is distinguished by absence of a subrostral fold, gill opening reaching ventrally to the 2nd pectoral ray, included lower jaw, right-angled chin, short snout, 3+1 round radials, elliptical body, uniform black colour, and normally developed anterior dorsal-fin rays. Most similar to *P. labiatus* but differs in the absence of the subrostral fold (*v.* present and deep anteriorly), in having lip posteriorly narrowed (*v.* distinctly wide), mouth subterminal (*v.* terminal), lower jaw deep below posterior end of oral cleft (*v.* shallow), opercular flap sharp-tipped and dorsally notched (*v.* ear-shaped).

*Paraliparis ater* n.sp.

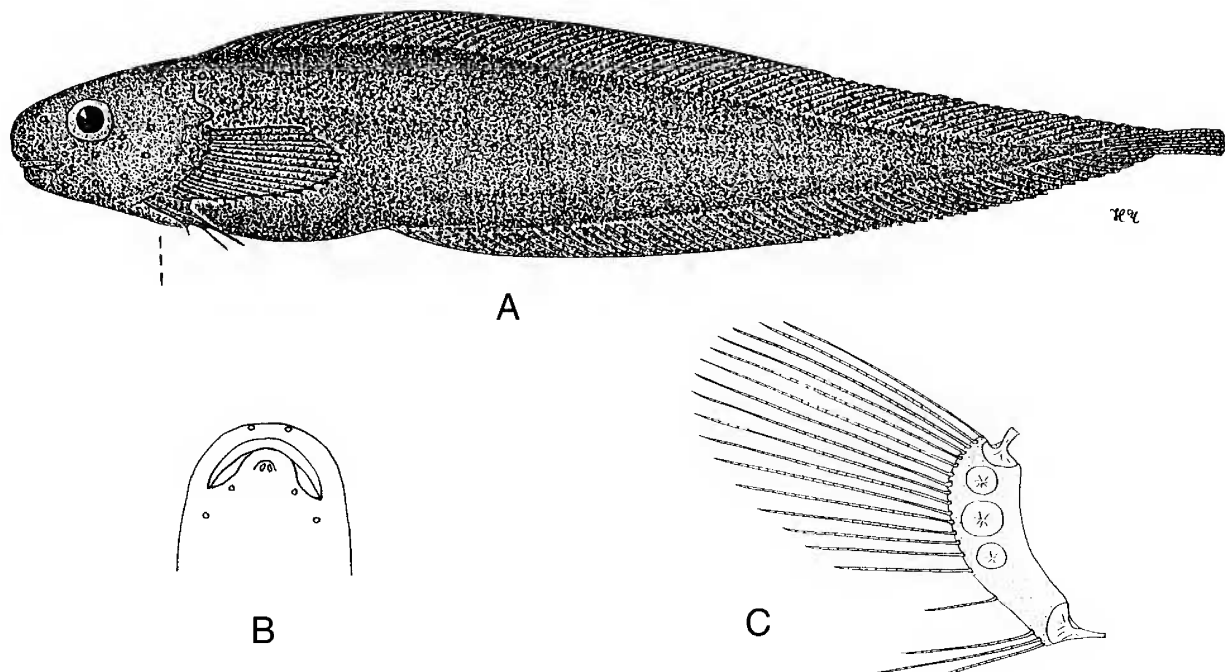
Fig. 21

**Material examined.** HOLOTYPE CSIRO H749-04, ripe ♀, 140 mm TL, 124 mm SL. FRV *Soela*, stn. So 3/86/32, 41°45.8'S 144°24.8'E, W coast of Tasmania, W of Granville Harbour, 16 May 1986, 1000–992 m; radiograph 680 F 2; pectoral girdle 794.

**Diagnosis.** Vert. 67, D 62, C 8, radials 3. First dorsal interneural between neural spines 3 and 4. Mouth horizontal, subterminal, small; teeth simple, small. Lower jaw subterminal. Interorbital wide, 2.1 eye. Chin pores with anterior common skin fold, interspace less than diameter. Ventral end of gill opening and dorsal pectoral ray horizontal with lower half of eye. P 16+1+3, rudimentary notch rays absent. Head 18.3% SL, ma large, 14.6%. Nephrohaemal canal present. Colour black, peritoneum black.

**Further description.** Counts: D 62, A 53, P 20, C 8 (4/4), Vert. 67 (11+56), radials 3+0, gr 7, pc 6, pores 2-6-7-1. Ratios: HL 18.3, its width 10.9 (60), and depth 15.4 (84), bd 17.6 (96), bdA 16.2 (89), preD 20.6, preA 36.7, ma 14.6, aAf 20.0, UPL 12.7 (70), LPL 10.7 (59% HL, 84% UPL), NL —, E 4.0 (22.2), gs 3.8 (20.9), sn 5.7 (31.3), po 8.9 (49), io 8.6 (47.0), so 3.0 (16.5), uj 8.1 (44), lj 7.8 (42.6), pc 4.7.

Head small, 5.5 in SL, evenly sloping anteriorly to rounded snout, depth 1.4 width. Eye small, not touching dorsal contour of head, suborbital space about  $\frac{2}{3}$  eye diameter. Pupil about  $\frac{1}{3}$  eye. Interorbital space wide, 2.1 eye. Snout 1.4 eye, bluntly rounded, slightly projecting beyond upper jaw, its highest point level with upper margin of pupil. Subrostral fold present, shallow and almost absent, not covering upper lip. Nostril pore-like, horizontal with mid-pupil. Mouth subterminal, horizontal and small, oral cleft reaching only to below anterior margin of eye. Lower jaw subterminal, teeth simple, very small, only slightly prominent, in 21–23 rows of up to 8–9 teeth anteriorly. Diastemae narrow, almost absent. Lower jaw tapering anteriorly, chin rounded in ventral view. Circumoral pore rims slightly thickened. Chin pores slit-like, interspace pigmented, less than their diameter, with thin common skin fold anteriorly. Chin symphysis slanted posteroventrally in lateral view, not right-angled. Gill opening small, 0.9 eye,



**Figure 21.** *Paraliparis ater* n.sp. A, holotype, CSIRO H749-04, ripe ♀, 140 mm TL, 124 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 794, cleared and stained right pectoral girdle.

its lower end level with eye centre. Opercular flap small, triangular, tip rounded, horizontal with upper margin of pupil, covering lower half of gill opening.

Uppermost pectoral ray level with lower margin of pupil, ventralmost ray below anterior third of postorbital space. Pectoral upper lobe not reaching to anal-fin origin, lower lobe c. 84% UPL. P 16+1+3, rudimentary rays absent. Skin of pectoral fin damaged, notch membrane apparently attached to body almost at full ray length. Radials 3+0, round, fenestrae absent. Coracoid with thin, comparatively short helve.

Body elliptic, not deep, 5.7 in SL (96% HL), deepest between dorsal and anal-fin origins; dorsal contour broadly rounded anteriorly and posteriorly from this point, dorsal and ventral contours similar. Horizontal midline touching lower margin of pupil. Preanal distance long, 37% SL. Interneural of first dorsal ray between neural spines 3 and 4, free interneural absent. Anterior dorsal rays embedded in gelatinous tissue. Parapophyses of vertebrae 5–11 obviously joined, forming nephrohaemal canal. Epineural ribs on vertebrae 2–9, up to 3 vertebrae in length; epipleural ribs on vertebrae 4–16, slim, not clearly visible on radiograph, up to 1.5 vertebrae in length; costal keel detectable, but weak. Anus below posterior third of postorbital space. Vertical fins overlapping caudal fin slightly more than half. Skin thick, opaque, prickles absent. Gelatinous tissue moderately well developed. Genital papilla absent. Individual mature, a few ripe eggs in oviduct up to 2.4 mm, ovarian eggs much smaller. Sexually mature at a short length, about 126 mm SL. Pyloric caeca, thick, with sharp tips.

**Colour.** Body and head uniformly black; lips and inner surface of subrostral fold almost as black as head; chin slightly paler, dark grey. Pores pale inside. Mouth grey, tooth plates dark, tongue slightly lighter, grey-dotted. Branchial cavity brownish-black, gill arches grey. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** West coast of Tasmania, 1000–992 m.

**Etymology.** *Ater* in Latin, meaning black as soot.

**Comparative notes.** *Paraliparis ater* belongs to group IIIc. It is distinguished by a nephrohaemal canal, anterior dorsal-fin origin (between neural spines 3 and 4, free interneurals absent), wide interorbital 47% HL, short oral cleft (extending posteriorly to below the anterior margin of the eye), pectoral girdle with radials 3+0, round, fenestrae absent; by its uniformly dark black colour (lips as dark as the head), and in the shape of the opercular flap.

*Paraliparis atrolabiatus* n.sp.

Fig. 22

**Material examined.** HOLOTYPE CSIRO H550-11, mature ♂, 127 mm TL, 114 mm SL. FRV *Soela*, stn. So 3/86/36, 42°20.45'S 144°40.4'E, W coast of Tasmania, W of Cape Sorell, 1120–1220 m, 17 May 1986; radiograph 680 G; pectoral girdle 788.

**Diagnosis.** Vert. 68, D 60, C 8, radials 2. Mouth subterminal, teeth small. Chin pore interspace equals twice their diameter; common skin fold present anteriorly. Gill opening short, lower end horizontal with eye centre. Pectoral fin 16+2+3,

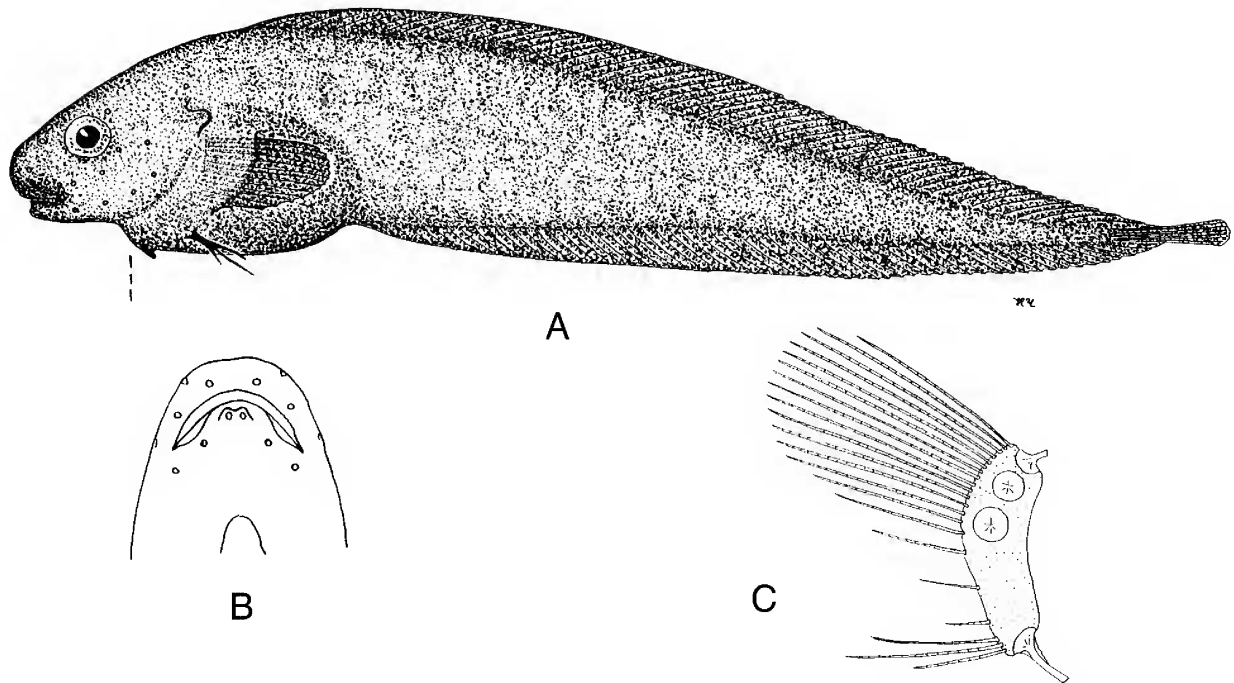
short, only posterior part of upper and lower lobes protruding from skin; notch shallow. Anus below first third of postorbital space. HL 19.3% SL, aAf short, 18.8% SL, preA 32% SL. Nephrohaemal canal present. Body and head light brown, peritoneum black, mouth dark grey, tongue black-dotted.

**Further description.** Counts: D 60, A 55, P 21, C 8 (4/4), Vert. 68 (11+57), radials 2 (2+0+0), gr 7, pc 4, pores 2-6-7-1. Ratios: HL 19.3, its width 13.0 (67), and depth 15.8 (82), bd 18.4 (95), bdA 17.5 (91), preD 21.9, preA 31.6, ma 12.2, aAf 18.8, UPL 11.8 (61), LPL 7.2 (37% HL, 61% UPL), NL 1.9 (16.4% UPL), sn 7.1 (36.8), E 4.5 (23.2), gs 3.1 (15.9), po 9.6 (50), io 7.9 (41), so 3.9 (20.5), uj 8.8 (45.5), lj 8.9 (46), pc 6.1.

Head short, 5.2 in SL, and wide, its width 67% HL, its depth 1.2 its width. Dorsal contour of head deep at occiput, gradually sloping in anterior profile. Snout projecting, extending above upper jaw, its most anterior point below horizontal through eye centre; snout length 1.6 eye diameter. Subrostral fold present, not deep, covering upper lip about half. Eye not large, 4.3 in HL, its contour not touching dorsal profile of head, suborbital space almost equal to eye. Pupil c. half eye diameter. Interorbital space 1.8 eye diameter. Nostril small, pore-like, horizontal with lower half of pupil. Mouth subterminal, its cleft reaching to below anterior third of eye. Lower jaw subterminal (shorter than upper, but not included). Depth of lower jaw below end of mouth cleft quite deep. Teeth small, slightly prominent, in about 20 rows of up to 8–9 teeth anteriorly. Diastemae absent from both jaws. Circumoral pores small, not contoured (rims not thickened), at surface, not in pits. Chin pore interspace pigmented, twice their diameter, chin pores small, longitudinally oval, anterior shallow skin fold present. Gill opening short, 0.7 eye diameter, vertical, its upper end above eye level, lower end on horizontal through pupil. Opercular flap small, rounded, covering  $\frac{3}{4}$  of gill opening, its tip level with upper margin of eye.

Dorsalmost pectoral ray on horizontal through upper half of pupil, base of ventralmost on vertical through middle of postorbital space. P 16+2+3, notch rays short (16% UPL), rudimentary rays absent. Pectoral lobes not reaching anal-fin origin; lower lobe short, only 37% SL, 7.2% SL. Skin on body covering proximal half of upper lobe, only its posterior half free and movable; lower fin lobe about  $\frac{1}{3}$  covered; notch rays covered by skin entirely; free portions of upper and lower lobes appear separate and unjoined by fin membrane. Radials 2 (2+0+0), fenestrae between radials absent. Scapula with a strong shaft. Coracoid with a very long thin helve.

Body not deep, greatest depth at anterior dorsal-fin ray, about 95% HL. Not hump-backed, dorsal profile gradually rounded; ventral contour straight. Preanal distance short, 31.6% SL. Haemal spine of last abdominal vertebra (12) equals about half next (13). Vertebrae 35 and 36 damaged, healed. First dorsal rays not rudimentary, gradually elongated; first ray-bearing interneural between neural spines 6 and 7; two free anterior interneurals present between 4th, 5th, and 6th neural spines. Costal ridges weakly developed. Epineural and epipleural ribs slender, thin, short, on vertebrae 3–19, 2 vertebrae or less in length. Nephrohaemal canal present: parapophyses of vertebrae 3–11 joined to form very short haemal spines, directed anteriorly at vertebrae 5–7. C 4/4. Vertical fins overlap caudal about



**Figure 22.** *Paraliparis atrolabiatus* n.sp. A, holotype, CSIRO H550-11, mature ?, 127 mm TL, 114 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 788, cleared and stained right pectoral girdle.

half. Anus below  $\frac{1}{3}$  of postorbital space, aAf short. Skin unprickled, thin, semitransparent. Subcutaneous gelatinous tissue well developed. Pyloric caeca of similar lengths. Specimen an adult male with ripe testes and prominent cone-like urogenital papilla below middle of postorbital space. Males mature at small length, about 114 mm SL.

**Colour.** Skin light brown with broad markings; head much lighter than body, yellowish. Pectoral fin, margin of opercular flap and urogenital papilla blackish. Inner surface of subrostral fold and lips distinctly darker than head, dark blackish-brown. Mouth dark grey, darker than head, tongue black-dotted. Tooth plates pale, gill arches light grey-dotted, branchial cavity dark grey, almost black. Peritoneum black, stomach and pyloric caeca pale.

**Distribution.** West coast of Tasmania, 1120–1220 m.

**Etymology.** The name derives from Latin *atro*—dark and *labium*—lip.

**Comparative notes.** *Paraliparis atrolabiatus* is in group IIIc; it is distinguished by its broad head, peculiarly skin-bound pectoral fins with short lower lobes, short gill opening, short distance between anus and anal fin, light-brown body and yellowish head, two pectoral radials, and the nephrohaemal canal. Externally it is most similar to *P. auriculatus*, which has a similar pectoral fin and chin pores, but it differs from the latter in presence of a nephrohaemal canal (*v.* absence), two radials (*v.* 3), interradiar fenestrae absent (*v.* two small present), snout normal (*v.* strongly angled, almost absent), light brown head (*v.* dark brown), lips blackish-brown, darker than head (*v.* grey, lighter than head), mouth dark grey and darker than head (*v.* grey, lighter than head), anterior dorsal rays gradually elongated (*v.* 4 anterior rays distinctly shorter than following), and anus below anterior third of postorbital space (*v.* below posterior third).

### *Paraliparis auriculatus* n.sp.

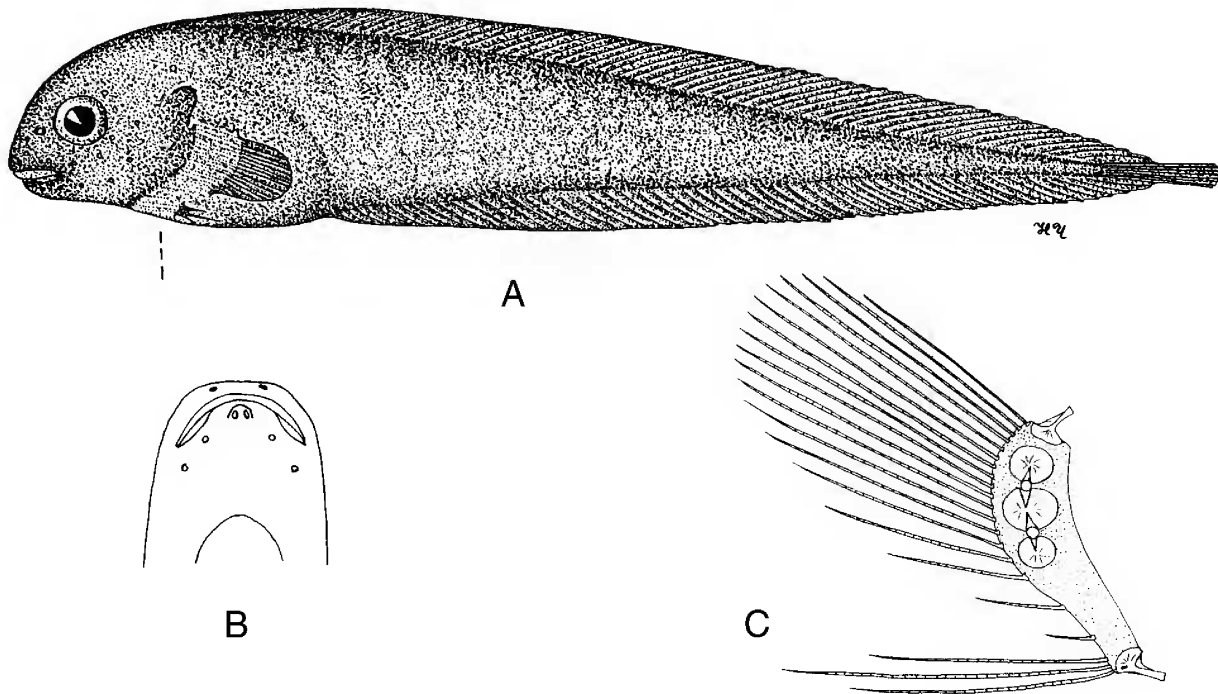
Fig. 23

**Material examined.** HOLOTYPE CSIRO H749-06, ♀, 145 mm TL, 131 mm SL. FRV *Soela*, stn. So 3/86/32, 41°45.8'S 144°24.8'E, W coast of Tasmania, W of Granville Harbour, 1000–992 m, 16 May 1986; radiograph 680 F4; pectoral girdle 740.

**Diagnosis.** Vert. 68, D 62 (4+58), anterior 4 rays short and thin, C 8, radials 3, notched. Mouth subterminal, teeth tiny, tooth plates smooth. Snout not protruding, angled posterodorsally from immediately above upper lip. Eye 25.4%, io 48% HL. Chin pore interspace equal to their diameter, with a common shallow skin fold anteriorly. Gill opening small, 0.6 eye. Pectoral fin 16+2+3, with short lobes, posterior half only of upper and lower lobes protruding from skin. Anus slightly anterior to gill opening. HL 18.6%, preA distance short, 29%, aAf 16.7% SL. Skin dark brown, peritoneum black, mouth grey, tongue black-dotted.

**Further description.** Counts: D c. 62 (4+58), A c. 55, P 21, C 8 (4/4), Vert. 68 (12+56), radials 3 (3+0), gr 9, pc 4, pores 2-6-7-1. Ratios: HL 18.6, its width 11.1 (60), and depth 15.3 (82), bd 16.8 (90), bdA 16.8 (90), preD 20.6, preA 29.0, ma 13.7, aAf 16.7, UPL 11.7 (63), LPL 9.9 (53% HL, 84% UPL), NL 1.6 (13.6% UPL), sn 6.5 (34.8), E 4.7 (25.4), gs 3.1 (16.4), po 9.1 (49), io 9.0 (48.3), so 2.4 (13.1), uj 8.0 (43), lj 7.3 (39), pc 5.

Head short, 5.4 in SL, not much compressed, its width 60% HL, its depth 1.4 its width. Dorsal contour of head deep at occiput, widely rounded in anterior profile. Snout deep, strongly angled, almost absent in lateral view, its highest point horizontal with upper margin of eye, tip just above upper lip; length from maxillary symphysis to anterior



**Figure 23.** *Paraliparis auriculatus* n.sp. A, holotype, CSIRO H749-06, ♀, 145 mm TL, 131 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 740, cleared and stained right pectoral girdle.

margin of eye 1.4 eye diameter. Subrostral fold present, deep but not completely covering upper lip. Eye quite large, 3.9 in HL, its contour not touching dorsal profile of head, suborbital short, half of eye. Pupil c.  $\frac{2}{3}$  eye diameter. Interorbital space rounded, broad, 1.8 eye diameter. Nostril small, pore-like, horizontal with lower margin of pupil. Mouth subterminal, its cleft reaching to below anterior margin of pupil. Lower jaw subterminal, almost included, deep below posterior of oral cleft. Teeth tiny, tooth plates appear smooth, in 23–25 rows of up to 8–9 teeth anteriorly. Diastemae absent. Circumoral pores small, chin pores interspaced at their diameter, small, longitudinally oval, interspace pigmented, anterior shallow skin fold present. Gill opening short, 0.6 eye diameter, its upper end slightly above eye level, lower end on horizontal through eye centre; dorsal end anterior to the lower. Opercular flap small, ear-shaped, its tip above level of upper margin of eye.

Dorsalmost pectoral ray on horizontal through centre of eye, base of ventralmost on vertical through middle of postorbital space. P 16+2+3, notch rays short (14% UPL), rudimentary rays absent. Pectoral lobes both short, not reaching anal-fin origin. Skin closely attached to body covering anterior half of upper lobe, leaving only posterior half of fin free and movable; lower fin lobe similar; notch rays covered by skin entirely; free parts of upper and lower lobes appear to be separate, not joined by fin membrane. Radials 3 (3+0), two small fenestrae between radials present. Scapula with a long shaft, on which a dorsal lateral rib is present. Coracoid with a small slit-like opening and a strong helve.

Body not deep, greatest depth at anterior ray of dorsal fin, about 90% HL. Not hump-backed, dorsal profile gradually rounded; ventral contour almost straight. Horizontal midline of body passes through upper margin of pupil. Preanal distance short, 29% SL. Haemal spine of last abdominal vertebra (12) about half the length of the

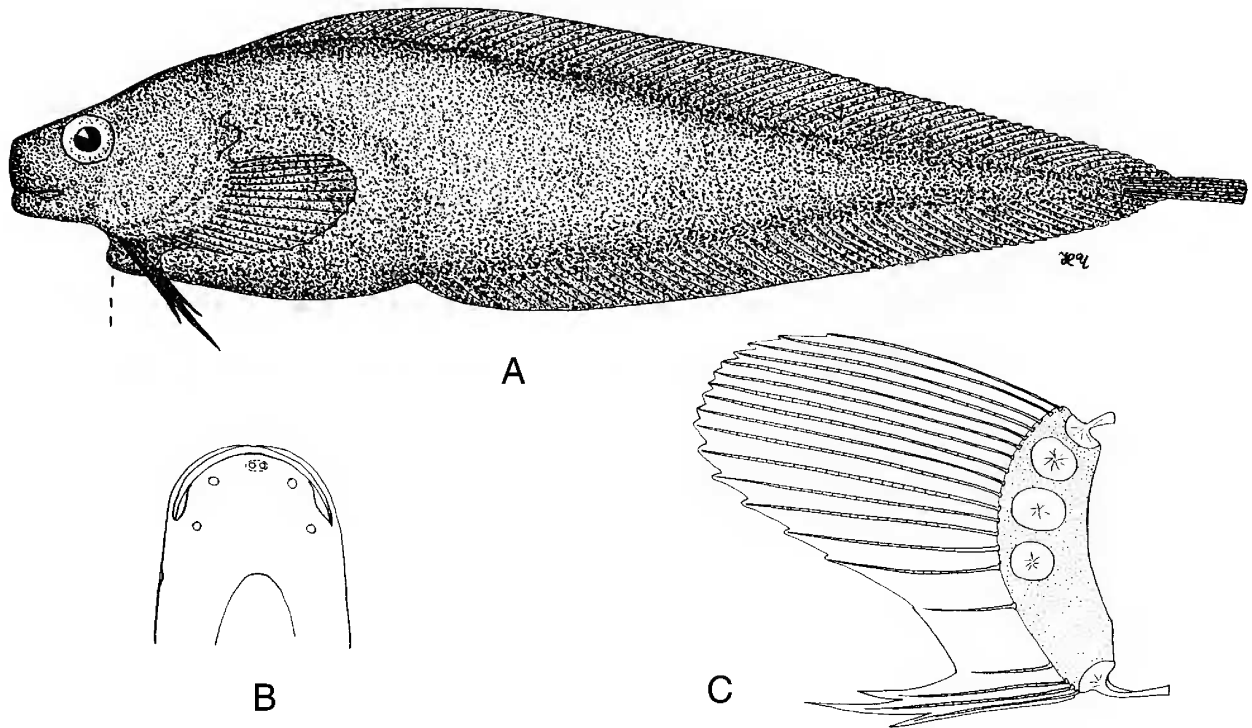
next. First dorsal ray rudimentary, its interneural between neural spines 5 and 6; free anterior interneurals present between 3rd, 4th, and 5th neural spines. Next three dorsal rays short and thin. Epineural ribs on vertebrae 2–14, epipleural ribs on 3–20, well developed but thin, about 2–2.5 vertebrae in length. Costal ridges weakly developed. C 4/4. Vertical fins overlap caudal by about half. Anus slightly anterior to gill opening. Skin quite thin, semitransparent. Subcutaneous gelatinous tissue well developed. Pyloric caeca of similar lengths. Specimen an adult female, one large ripe egg 3 mm in diameter present near oviduct opening, ovarian eggs much smaller and unripe.

**Colour.** Head and body dark, blackish-brown with irregular broad darker areas. Inner surface of subrostral fold, lips and mouth distinctly lighter, grey; tongue densely black-dotted. Tooth plates pale, gill arches light grey-dotted, branchial cavity dark brown. Peritoneum black, stomach and pyloric caeca pale.

**Distribution.** West coast of Tasmania, 1000–992 m.

**Etymology.** The specific epithet *auriculatus* from the Latin for small ear, *auricula* refers to the shape of the opercular flap.

**Comparative notes.** *Paraliparis auriculatus* is in group IIIc; it is distinguished by its peculiar skin-bound pectoral fin with short upper and lower lobes, small gill opening, ear-shaped opercular flap, snout not protruding, comparatively large eye and broad interorbital, more posterior position of the anus, the shortened anterior four dorsal rays, and tiny teeth. Among species of this group which have no nephrohaemal canal, it is the only one with 3+0 radials (v. 4). It is most similar to *P. retrodorsalis* in the posterior position of the dorsal origin, but differs from it in its short preanal distance of 29% SL (v. 37%), anus–anal-fin distance



**Figure 24.** *Paraliparis australiensis* n.sp. A, holotype, NMV A21497, ♀, 176 mm TL, 164 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 789, cleared and stained right pectoral girdle.

of about 17% SL (v. 26%), insertion of the first dorsal-fin interneural between neural spines 5 and 6 (v. between 7 and 8), two interneurals (v. 3), radials 3 (3+0) v. 4 (3+1), two small pectoral girdle fenestrae (v. none), diastemae absent (v. distinctly developed), tiny teeth (v. normal), dark brown colour (v. black), pale tooth plates (v. dark), and other characters.

***Paraliparis australiensis* n.sp.**

Fig. 24

**Material examined.** HOLOTYPE NMV A21497, ♀, 176 mm TL, 164 mm SL. FRV *Soela*, stn. So 1/88/09, 37°01.09'S 137°25.44'E, 100 km S of Kangaroo Island, South Australia, 1090–1160 m, 24 Jan. 1988; radiograph NMV 5873E; pectoral girdle 789.

**Diagnosis.** Vert. 65, D 60, C 8, radials 3, round. Eye nearly touching dorsal contour. Snout blunt, large, 37.5% HL. Mouth terminal, horizontal, teeth very small. Chin pore pair in a common pit, interspace equals pore diameter. Gill opening ventral end horizontal with lower third of eye. P 16+0+4, upper lobe short, 63% HL, notch rays absent. Body deep, 125% HL. HL 19.5% SL, preA 34.5% SL, aAf long, 30% SL. Colour very dark blackish-brown, peritoneum black, mouth and tongue grey.

**Further description.** Counts: D 60, A 54, P 20, C 8 (4/4), Vert. 65 (11+54), radials 3 (3+0), round, gr 9, pc 5, pores 2-6-7-1. Ratios: HL 19.5, its width 12.8 (66) and depth 16.3 (84), bd 24.4 (125), bdA 20.4 (105), preD 24.4, preA 34.5, ma 12.5, aAf 30.0, UPL 12.2 (63), LPL 10.5 (59% HL, 95% UPL), notch rays absent, E 4.6 (23.8), gs 3.8 (19.3), sn 7.3 (37.5), po (51.6), io 7.5 (38.4), so 2.7 (14.0), uj 8.5 (44), lj 7.9 (40.6), pc 9.8.

Head small, 5.1 in SL, quite deep at occiput, dorsal contour slopes steeply anteriorly and much more gently posteriorly. Head not much compressed, depth 1.3 its width. Snout large, deep, and blunt, its highest point horizontal with upper margin of pupil; in lateral view, snout length about equal to eye; length from symphysis of upper jaw to anterior margin of eye is 1.6 eye diameter. Subrostral fold deep, covering upper lip almost entirely. Eye almost touching upper contour of head, suborbital about 0.6 eye diameter, pupil about half eye diameter. Interorbital space 1.6 larger than eye. Nostril level with eye centre, with raised rim, twice diameter of snout pores. Mouth terminal, horizontal, its cleft not quite reaching to below anterior margin of pupil. Lower jaw subterminal, almost included, chin widely rounded, quite gelatinous, shallow below posterior end of oral cleft. Teeth very small, slightly prominent, in 25–26 quite regular rows, curving anteriorly on tooth plates, up to 10–12 teeth per row anteriorly. Diastema of upper jaw narrow, absent in lower jaw. Circumoral pores small, with slightly raised rims; chin pores in a shallow small oval pit, interspace pigmented, equal to pore diameter. Chin pore diameter half that of pm<sub>2</sub>. Gill opening 0.9 eye diameter, its upper end slightly above level of upper margin of eye, lower end horizontal with lower third of eye. Opercular flap ear-shaped, upper margin notched, tip level with upper margin of pupil.

Upper pectoral ray horizontal with lower margin of eye, lowermost ray about below posterior margin of eye. Pectoral fin 16+0+4, deeply notched, lowest upper lobe ray slightly farther from remainder of rays; upper and lower lobes connected by fin membrane, normal notch rays absent. Upper lobe short, not reaching anal-fin origin. Skin of proximal surface of upper lobe attached to body at ray bases, in notch at about ½ ray length, and in lower lobe at about ⅓ ray length. Pectoral girdle with 3+0 round radials, fenestrae

in cartilaginous basal lamina absent. Coracoid with a very long thin helve.

Body deep, elliptic, 125% HL, greatest depth at dorsal-fin origin, depth at A origin about equal to eye (105%). Horizontal midline touches lower margin of pupil. Anterior dorsal rays embedded in gelatinous tissue; first dorsal ray short, its interneural between vertebral spines 4 and 5; anterior free interneurals absent. Parapophyses at least of abdominal vertebrae 10 and 11 joined, length of haemal spine of vertebra 11 almost equal to next, not reaching first interhaemal. Costal ridges weakly developed. Epineural ribs present on vertebra 2–17, epipleural ribs on vertebrae 4–17, both thin, not stout, lengths up to 1.5 vertebrae. Anus just behind a vertical through eye; distance between anus and anal fin noticeably greater than HL. Skin quite thin, prickles absent. Vertical fins overlapping anterior third of caudal. Pyloric caeca similar, quite thick at their bases and long. Ripe eggs in oviduct c. 2.7 mm in diameter.

**Colour.** Head and body very dark, uniformly blackish-brown, chin and lips dark grey, inner side of subrostral fold black. Mouth and tongue uniformly light grey, tooth plates dark, branchial cavity black, gill rakers grey. Pores as dark as head, not whitish. Peritoneum black, stomach and pyloric caeca pale.

**Distribution.** Off South Australia at 1090–1160 m.

**Etymology.** The specific epithet—*australiensis*—refers to the country of origin of this new species.

**Comparative notes.** *Paraliparis australiensis* belongs to group IIIb, but is distinguished by its large blunt snout, short upper pectoral lobe, great distance between anus and anal fin, deep body, small teeth, absence of notch rays in the pectoral fin, 3 round radials, by a deep subrostral fold, and by lip and head of similar colour. In this group, only *P. csiroi* lacks normal rays in the pectoral-fin notch, but *P. australiensis* clearly differs from it in having the parapophyses of only abdominal vertebrae 10 and 11 joined (v. vertebrae 5–11 joined in very short spines creating a nephrohaemal canal), eye touching the dorsal contour of the head (v. not touching), a well-developed subrostral fold almost covering the upper lip (v. absent), wider head 66 (v. 54)% HL, chin pores in a common depression on lower surface of chin (v. in a common depression on the anterior surface of chin), diastema of upper jaw narrow, of lower jaw absent (v. diastema of lower jaw slightly wider than that of upper jaw), pyloric caeca lengths 9.8 (v. 4.6)% SL, darker blackish-brown colour (v. dark brown), fenestrae in pectoral girdle absent (v. one present), and lip colour similar to that of head (v. lighter).

***Paraliparis avellaneus* n.sp.**

Fig. 25

**Material examined.** HOLOTYPE NMV A5873, ♂, 149 mm TL, 132 mm SL. FRV *Soela*, stn. So 1/88/09, 37°01.09'S 137°25.44'E, 100 km S of Kangaroo Island, South Australia, 1090–1160 m, 24 Jan. 1988; radiograph NMV 5873E; pectoral girdle 735.

**Diagnosis.** Vert. 65, D 58, 7 anterior rays short; C 8, radials 3, round. Head and body low, mouth oblique. Teeth tiny.

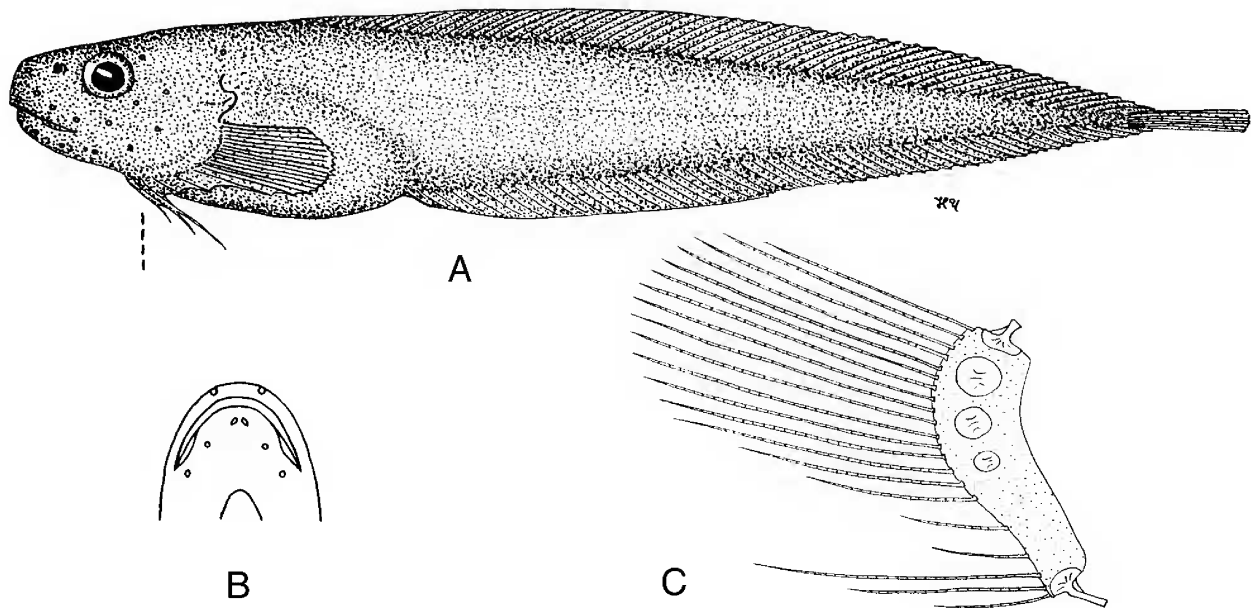
Chin pores interspaced by their diameter, not in a pit. Gill opening short, lower end slightly below level of eye. Pectoral fin 21, upper lobe short, about 60% HL; rudimentary rays absent. Head 19% SL, preA 35%; bd 90% HL. Colour nut-brown, skin thin. Peritoneum black.

**Further description.** Counts: D 58, A 54, P 21, C 8 (4/4), Vert. 65 (10+55), radials 3 (3+0), pc 5, gr 8, pores 2-6-7-1. Ratios: HL 18.8, its width 10.6 (56) and depth 12.9 (69), bd 16.7 (89), bdA 14.5 (72), preD 25.8, preA 35, ma 13.6, aAf 22.7, UPL 11.4 (60.5), LPL 10.6 (93% UPL), NL c. 3.4 (30% UPL), E 4.5 (24.2), gs 3.9 (20.6), sn 6.1 (32.3), po 9.1 (48), io 6.4 (34.3), uj 8.4 (45.2), lj 8.2 (43.5), so 2.9 (15.3), pc 4.5.

Head small, 5.3 in SL, quite compressed, its width 56% its length, and low, its depth 69% HL or 1.2 its width, dorsal contour almost horizontal, slightly declining anteriorly. Snout deep, blunt, 1.3 eye, not projecting anterior to upper jaw, not very gelatinous; its highest point level with upper margin of eye. Subrostral fold deep, entirely covering upper lip. Eye 4.1 in HL, almost entering upper profile of head; pupil about half eye diameter, suborbital distance 0.6 eye. Interorbital space narrow, a little more than 1/3 HL, 1.4 eye. Nostril small, on horizontal through upper margin of pupil. Mouth terminal, oblique; symphysis of upper jaw almost horizontal with lower margin of eye. Oral cleft reaching to vertical through anterior margin of eye. Lower jaw included by upper; moving upper lip allows margins of upper tooth plates to be seen. Lower jaw tapered anteriorly; chin rounded, in lateral view slanted, not gelatinous, not deep below end of oral cleft. Teeth extremely small, barely projecting above gums; surface of tooth plates appears smooth. Teeth in about 24–26 oblique rows of 7–8 teeth each anteriorly. Diastemae absent from both jaws. Circumoral pores small, not in pits; chin pores separated by a distance equal to their diameter, anterior skin fold absent, clearly not in a pit. Gill opening short, its length 0.9 eye diameter, its upper end level with upper half of pupil, its lower end slightly below horizontal through lower margin of eye. Opercular flap small, triangular with rounded tip, covering lower 2/3 of gill opening, tip level with lower margin of pupil.

Uppermost pectoral ray on horizontal through middle of suborbital space. Upper lobe short, not nearly reaching anal-fin origin. Fin deeply notched, 21 (16+2+3), rudimentary rays absent. Lower lobe comparatively long, of 3 rays, uppermost longest (93% UPL); lowermost inserted just behind the vertical through posterior margin of eye. Membrane of proximal surface of upper lobe attached at bases of rays, of notch at about 2/3 ray length, of lower lobe at about 1/3 lobe length. Radials 3+0, round. Fenestrae absent. Scapular helve short, with small upper rib; coracoid helve long, thin.

Body relatively shallow, its dorsal contour almost straight, greatest depth (at dorsal-fin origin) less than head length (ca 90% HL). Horizontal through midbody touches lower margin of eye. Preanal length 35% SL. Vertebral column almost straight anteriorly. Abdominal vertebrae 10. Parapophyses of 10th vertebra short, not forming a haemal spine. First dorsal-fin ray rudimentary, between 5th and 6th neural spines; next 6 dorsal rays thin, shortened. Free interneurals absent. Costal ridges absent. Epineural ribs on 3rd to 6th vertebrae, thin, their length not exceeding the length of 2.5 vertebral bodies. Epipleural ribs on 4th–11th vertebrae, short and thin, lengths about 1.5 vertebrae. Caudal fin 4/4, procurrent rays absent. Anus on vertical just behind eye. Skin thin, translucent. Gelatinous tissue poorly



**Figure 25.** *Paraliparis avellaneus* n.sp. A, holotype, NMV A5873, ♂, 149 mm TL, 132 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 735, cleared and stained right pectoral girdle, fin rays reconstructed from left side.

developed. Vertical fins overlapping caudal about  $\frac{1}{3}$  of its length. Pyloric caeca 5, similar in length, 14.5% SL.

**Colour.** Head and body pale nut-brown, slightly darker posteriorly. Mouth grey, tongue pale, densely black-dotted. Inner surface of subrostral fold light nut-brown. Gill arches black-dotted. Branchial cavity dark brown. Peritoneum black. Stomach and pyloric caeca pale.

**Distribution.** Off South Australia at 1090–1160 m.

**Etymology.** The specific epithet derives from the Latin *avellaneus*, nut-brown.

**Comparative notes.** *Paraliparis avellaneus* is a member of Group I, and is similar to *P. eastmani* and *P. brunneo-caudatus* in having an oblique mouth, but differs from the former in the number of vertebrae 65 (v. 69), dorsal-fin rays 58 (v. 64), pectoral radials 3+0 (v. 2+0+0), and in the absence of procurent caudal-fin rays (v. 1+3/3+1), tiny teeth (v. large, stout), lower jaw included (v. protruding), eye almost entering dorsal profile of head (v. distinctly below it), body colour light brown (v. black), absence of diastemae (v. present), and light brown inner surface of the subrostral fold (v. black-dotted). See description of *P. brunneo-caudatus*, below, for differences from it.

#### *Paraliparis badius* n.sp.

Fig. 26

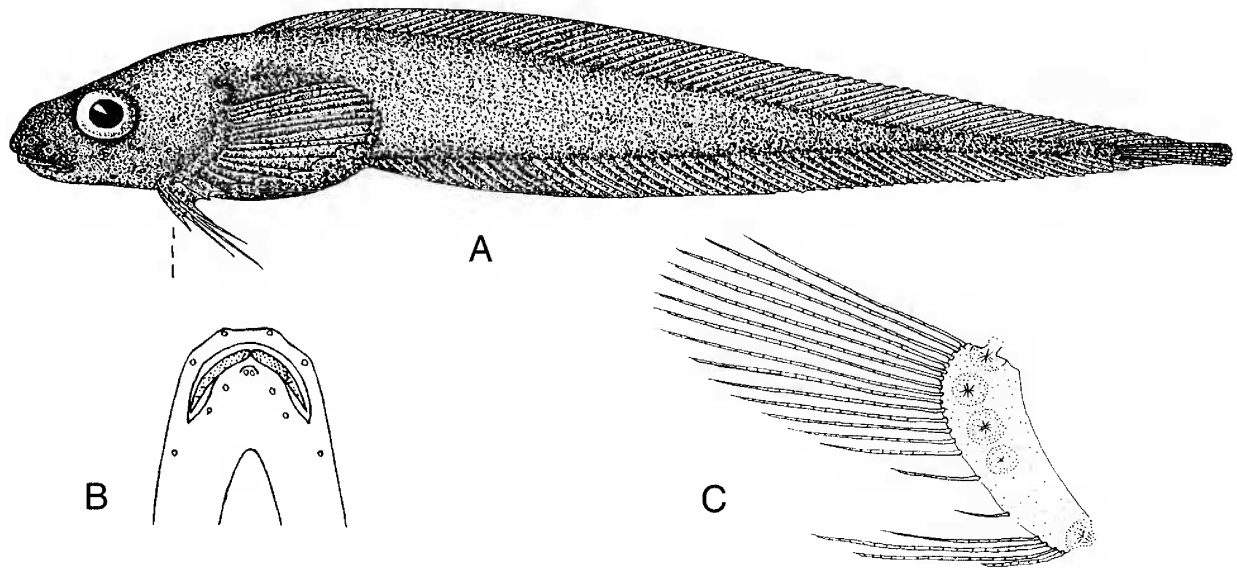
**Material examined.** HOLOTYPE CSIRO T1981-01, juvenile, 90 mm TL, 82 mm SL. Coordinates of capture location unknown, off Tasmania, depth unknown, 20 Oct. 1984; radiograph 687B; pectoral girdle 781.

**Diagnosis.** Vert. 65, D 63, A 55, C 8, radials 3, round. Mouth inferior, lower jaw included. Subrostral fold absent. Teeth

simple, not large, but prominent. Chin pores closely set, with common thin skin fold anteriorly. Gill opening short, half of eye. Lower end of gill opening and uppermost pectoral fin on horizontal with upper margin of pupil. P 20–21 (14–15+2+4), rudimentary notch rays absent. Head 20% SL, eye large, 29% HL. Preanal length c. 33%, aAf short, 15.9% SL. Vertical fins overlap half of caudal. Head brown, mouth black, tongue black-brown-dotted.

**Further description.** Counts: D 63, A 55, P 20–21, C 8 (4/4), Vert. 65 (9+56), radials 3 (3+0), gr 5, pc 5, pores 2-6-7-1. Ratios: HL 20.2, its width 11.5 (56.6), and depth 14.6 (72.3), bd 14.0 (69.3), bdA 13.4 (66), preD 24.4, preA 32.7, ma 13.4, aAf 15.9, UPL 13.4 (66), LPL 12.8 (95% UPL), E 5.9 (28.9), gs 3.0 (15.1), sn 6.7 (33.1), po 9.5 (47), io 7.4 (36.7), so 3.7 (18), uj 9.0 (44.6), lj 8.3 (41.0).

Head moderately large, about 4.9 in SL, not deep at occiput but greatly sloping anteriorly; quite compressed (width 57% HL), depth 1.3 its width. Ventral surface of head flat. Eye large, almost 3.5 in HL (probably slightly smaller in adults), almost touching dorsal profile of head. Pupil about half eye diameter. Interorbital width 1.3 eye, suborbital distance 0.6 eye. Snout wide, gelatinous, its length 1.1 eye; profile slanted, clearly projecting beyond upper jaw, highest point on horizontal with upper margin of pupil. Subrostral skin fold absent, upper lip entirely visible. Nostril on level with upper half of pupil. Mouth inferior, its cleft reaching to below anterior margin of eye, lower jaw included. Teeth simple, not small, prominent, about 15 rows of up to 7 teeth each anteriorly in jaws. Diastema absent in both jaws. Circumoral pores small, not contoured, rims not thickened. Chin pores almost touching each other, interspace pigmented, a thin anterior skin fold present. In ventral view, upper tooth plates entirely visible. Postorbital length short. Gill opening small, about half of eye diameter, lower end on horizontal with upper margin of pupil. Opercular flap small, rounded, its tip slightly above level of upper margin of eye.



**Figure 26.** *Paraliparis badius* n.sp. A, holotype, CSIRO T1981-01, juvenile, 90 mm TL, 82 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 781, cleared and stained right pectoral girdle, partially reconstructed using detail from left side. Incompletely ossified.

Uppermost pectoral ray level with upper margin of pupil. Upper pectoral lobe long, reaching to above anal-fin origin. P (L) 21 (15+2+4), (R) 20 (14+2+4). Rudimentary rays absent. Origin of lower lobe rays below first quarter of postorbital space. Pectoral skin missing. Cartilaginous basal lamina with 3 (3+0) round radials, fenestrae absent. Scapula, coracoid and radials barely ossified, consisting mainly of cartilage.

Body low, maximum depth about 70% HL, in adults probably slightly deeper. Dorsal contour gently curves ventrally anteriorly and posteriorly from above anal-fin origin, ventral profile straight. Preanal distance short. Horizontal through midline anteriorly touching upper margin of eye. Free dorsal interneurals absent; first dorsal ray between vertebrae 4 and 5. Anterior dorsal rays not rudimentary, embedded in gelatinous tissue. Vertical fins overlapping caudal slightly more than one-half its length. Anus below midst of postorbital space, aAf short. Skin lacking prickles, quite thin, semitransparent. Pyloric caeca similar.

**Colour.** Head and body uniformly brown, blackish around gill opening and on chin. Mouth black, tongue black-brown dotted, tooth plates pale. Subrostral fold inside and lips similar in colour to head. Circumoral pores whitish pale, distinctly contrasting with head colour. Branchial cavity dark grey, gill arches dotted. Peritoneum dark brown, pyloric caeca and stomach light.

**Distribution.** Off Tasmania, depth unknown.

**Etymology.** *Badius* from the Latin meaning "dark brown", a reference to the overall body colour.

**Comparative notes.** *Paraliparis badius* is in group II. It differs in its large eye, short gill opening equal to half of eye, absent subrostral fold, chin pores almost touching, common skin fold anteriorly, aAf short, vertical fins overlapping half of caudal, and by its brown colour. It is most similar to *P. plagiostomus*, but differs from it in its brown colour (v. brownish-black), shorter mouth cleft

reaching to below anterior margin of eye (v. its centre), larger eye about 29 (v. 23)% HL, and shorter distance from anus to anal-fin origin 16% SL (v. 19). In addition, the subrostral skin fold is absent, so that the upper lip is entirely visible (v. a wide subrostral skin fold entirely covering the upper lip), pale tooth plates (v. dark grey), normal sized teeth (v. tiny, tooth plates smooth), and circumoral pores not contoured (v. distinctly contoured).

***Paraliparis brunneocaudatus* n.sp.**

Fig. 27

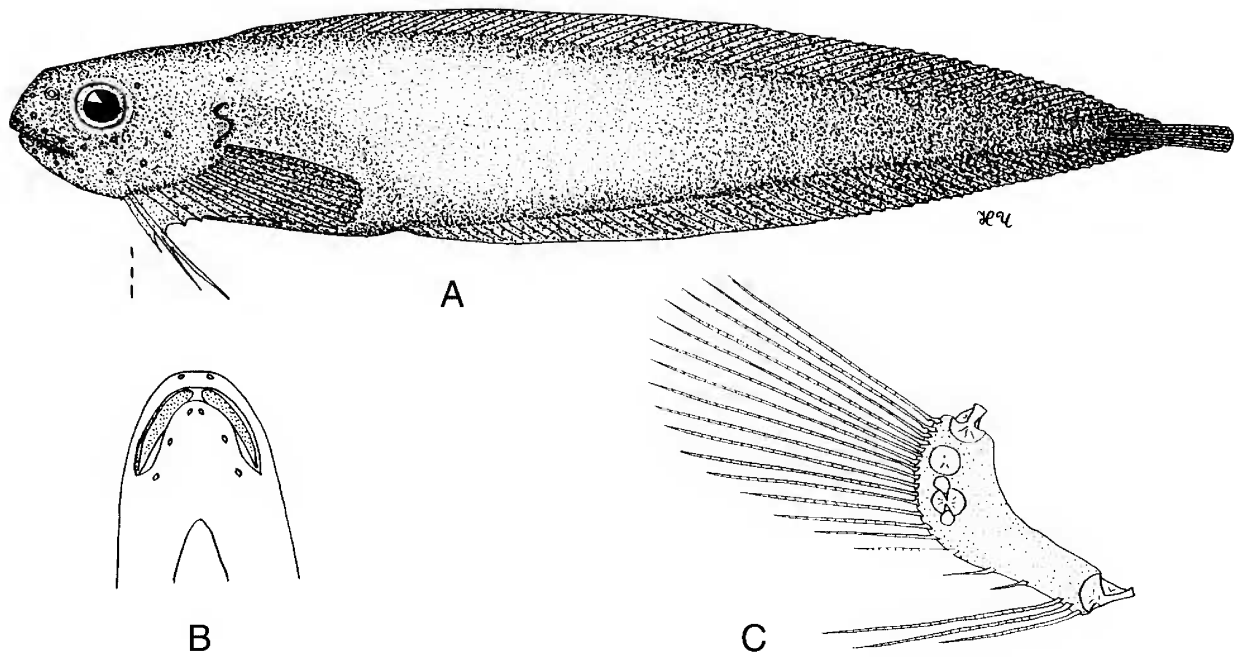
**Material examined.** HOLOTYPE CSIRO T1980-01, ♂, 142 mm TL, 127 mm SL. FV *Petuna Endeavour*, collection coordinates unknown, W coast of Tasmania, collection depth unknown, Apr. 1984; radiograph 681A; pectoral girdle 780.

**Diagnosis.** Vert. 66, D 62, C 8, radials 2. Eye low on side of head, suborbital space equal to half of eye. Mouth oblique, lower jaw included. Teeth strong, conical. Chin pores not in a pit. Dorsal end of gill opening on horizontal through eye centre. Pectoral fin 20–21 (15–16+2+3), with long lobes, rudimentary notch rays absent. HL 19% SL, preA 37%. Anus on vertical just behind eye, aAf long. Colour bright reddish-brown, end of tail darker, blackish-brown. Skin thin, semitransparent. Mouth and tongue blackish-brown, brightly dotted.

**Further description.** Counts: D 62 (5+57), A 53, P 20–21, C 8 (4/4), Vert. 66 (11+55), radials 2 (2+0+0), pc 6, gr 7, pores 2-6-7-1. Ratios: HL 19.0, its width 10.6 (56.0), and depth 15.0 (79.0), bd 15.7 (83), bdA 18.1 (95), preD 21.6, preA 37.0, ma 15.0, aAf 24.9, UPL 14.2 (75), LPL 13.4 (94% UPL), NL c. 5.5 (39% UPL), E 4.7 (24.9), rim of dense whitish skin around eye 6.1 (32.4), so 2.8 (14.5), gs 4.3 (22.8), sn 6.3 (33.2), io 7.1 (37.3), uj 8.8 (46.5), lj 7.9 (41.5), pc 3.9.

Head small, 5.2 in SL, depth shallow at occiput (c. 80% HL), its dorsal contour only slightly sloping anteriorly. Head very compressed, its width 56% HL, depth 1.4 its width.





**Figure 27.** *Paraliparis brunneocaudatus* n.sp. A, holotype, CSIRO T1980-01, ♂, 142 mm TL, 127 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 780, cleared and stained right pectoral girdle.

Snout deep, its length 1.4 eye, slightly projecting above upper jaw, its highest point above eye level. Subrostral fold well developed, entirely covering upper lip. Eye large, 4 in HL, upper margin far below dorsal profile of head, suborbital distance very short, about half eye diameter. Eye surrounded by thick, whitish, dense skin, its diameter slightly larger than eye diameter, pupil about  $\frac{3}{4}$  eye diameter. Interorbital space 1.5 eye. Nostril pore-like, with raised rim, on horizontal with upper half of pupil. Mouth oblique, symphysis of upper jaw horizontal with lower margin of eye. Mouth cleft reaching to below anterior margin of eye. Lower jaw included, upper tooth plates entirely visible in ventral view. Lower jaw tapering anteriorly, tip of chin rounded, not gelatinous, quite deep below oral cleft. Teeth stout, quite sharp, conical, in 21–22 rows of 8–9 teeth anteriorly. Diastema of upper jaw wide, about half of tooth plate in width, that in lower jaw narrower. Circumoral pores small, not in pits or protruding. Chin pore pair separated by about their diameter, interspace pigmented. Gill opening small, 0.9 eye diameter, entirely above pectoral base; upper end on horizontal through eye centre, lower end below level of eye. Opercular flap small, ear-like, tip horizontal with lower margin of pupil, gill opening comparatively long.

Upper pectoral-fin ray slightly below level of lower margin of eye. P (L) 20 (15+2+3), (R) 21 (16+2+3), clearly notched, rudimentary rays absent. Upper lobe long, but not reaching anal-fin origin. Lower lobe also long, length c. 94% UPL. Pectoral skin attached almost at bases of upper lobe rays, elsewhere unknown. Basal cartilaginous lamina of pectoral girdle with two small radials, both located dorsally just below scapula; uppermost round, lower (R2) notched on both sides. Two fenestrae present at upper and lower margins of R2. Helve of scapula stout, with upper lateral rib. Coracoid has an elongated helve with upper lateral rib.

Body low, its greatest depth above anal-fin origin, 95% HL, dorsal contour only slightly curved ventrally. Horizontal midline of body anteriorly touching lower margin of eye.

Preanal 37% SL. Anteriormost 5 dorsal rays very short. Interneural of 1st dorsal ray between 3rd and 4th neural spines, free interneurals absent. Parapophyses of the last abdominal vertebrae not joined together. Haemal spine of 12th (first caudal) vertebra slightly shorter than the next. Costal ridges absent. Epineural ribs present on 3rd to 18th vertebrae, anteriormost thin and short, others not longer than three body vertebrae. Epipleural ribs on 3rd–16th vertebrae thin, anteriormost not longer than 2.5 body vertebrae. Vertical fins overlapping caudal about half. Anus on vertical just behind eye. Pyloric caeca 6, sizes similar, c. 4.7% SL. Skin thin, unprickled, semitransparent. Gelatinous subcutaneous layer weakly developed.

**Colour.** Head and trunk very pale, bright reddish-brown, darker posteriorly, end of tail dark, blackish-brown. Lips and chin darker than head, blackish; inner surface of subrostral fold black-dotted; mouth and tongue blackish-brown, brightly dotted. Pectoral fin dark brown. Peritoneum blackish-brown, stomach and pyloric caeca pale. Branchial cavity blackish, gill arches dusky.

**Distribution.** West coast of Tasmania, depth unknown.

**Etymology.** From Latin *brunneo* and *caudatus*, brown-tailed, referring to the more darkly pigmented tail.

**Comparative notes.** *Paraliparis brunneocaudatus* belongs to group I, but is distinguished by its reddish-brown skin with tail darker than head, narrow suborbital space (c. half of eye diameter), whitish, dense skin surrounding the eye, comparatively long distance between mandible and anus, long pectoral-fin lobes, blackish lips and chin, and black-dotted inner surface of the subrostral fold. It is most similar to *P. avellaneus* but differs in having 2 (v. 3) radials and 2 (v. no) fenestrae in the pectoral girdle, in having normally developed epineurals on vertebrae 3–18 and epipleurals on vertebrae 3–16 (v. poorly developed ribs on vertebrae 3–6

and 4–11); 1st dorsal interneural between neural spines 3 and 4 (v. between 5 and 6); colour reddish with darker tail (v. uniformly nut-brown); eye surrounded by a thick whitish rim (v. not), eye not nearly touching upper contour of head (v. almost touching), teeth stout, conical (v. tiny), and diastemae present and wide (v. absent).

*Paraliparis brunneus* n.sp.

Fig. 28

**Material examined.** HOLOTYPE CSIRO H749-05, ♀, 169 mm TL, 151 mm SL. FRV *Soela*, stn. So 3/86/32, 41°45.8'S 144°24.8'E, W coast of Tasmania, W of Granville Harbour, 1000–992 m, 16 May 1986; radiograph 682 A; pectoral girdle 741.

**Diagnosis.** Vert. 65, D 58, 2 anterior rays shortened, C 8, radials 4, two with rudimentary notches. Mouth subterminal, lower jaw subterminal. Teeth small. Chin pores one pore diameter apart, not in a pit but with anterior skin fold. Gill opening ventral end slightly below level of lower margin of eye. Pectoral fin 23 (18+1+4), rudimentary rays absent. HL 19.9% SL, preA 35%. Body dark brown, peritoneum black, mouth black, tongue densely black-dotted.

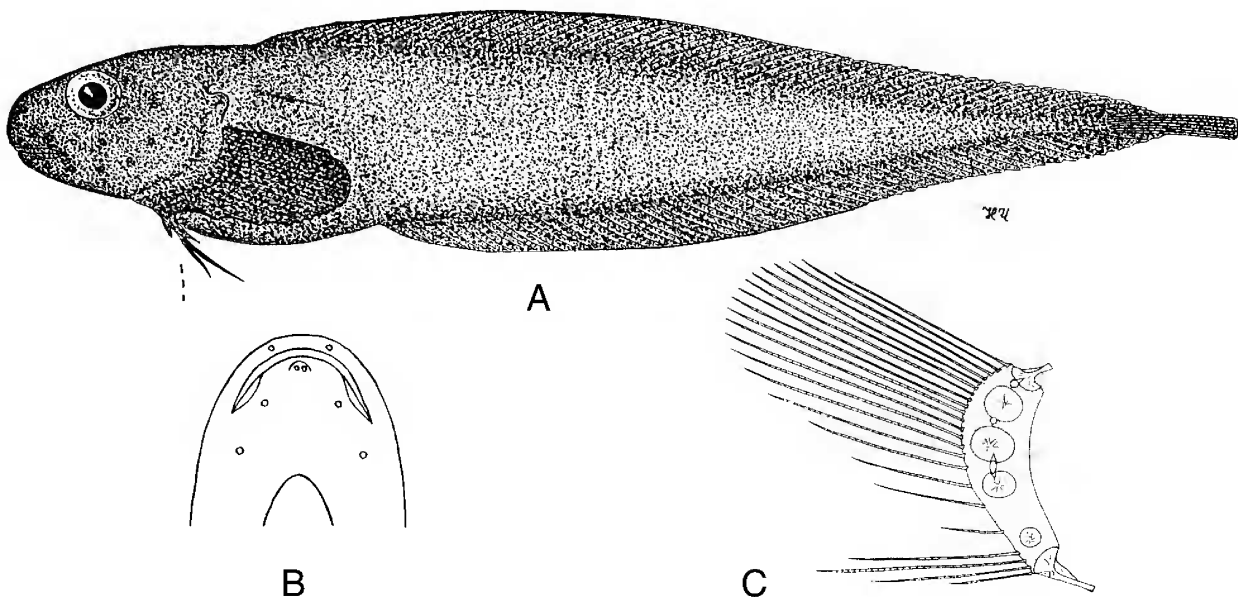
**Further description.** Counts: D 58, A 53, P 23, C 8, Vert. 65 (11+54), radials 4 (3+1) with 3 rudimentary fenestrae in pectoral girdle; pc 6, gr 7, pores 2-6-7-1. Ratios: HL 19.9, its width 11.7 (59), and depth 14.2 (72), bd 17.9 (90), bdA 16.2 (82), preD 24.5, preA 35.0, ma 13.9, aAf 22.6, UPL 13.2 (67), LPL 11.3 (57% HL, 85% UPL), NL 3.3 (25% UPL), E 4.8 (24.0), gs 4.0 (20), sn 7.3 (36.7), po 9.4 (47.3), io 8.5 (40), so 3.4 (17), uj 8.7 (44), lj 7.6 (38.3), pc 5.0.

Head small, 5.0 in SL, quite low and compressed, its depth 1.2 its width. Dorsal contour gradually sloping anteriorly. Snout large, deep, rounded, its length 1.5 eye,

most dorsal point horizontal with eye centre; not gelatinous, slightly projecting anterior to upper jaw. Subrostral fold present, deep but not covering upper lip entirely. Nostril small, pore-like, horizontal with eye centre. Eye quite large, its upper contour almost touching dorsal margin of head; suborbital space about 0.7 eye, pupil about half eye diameter. Interorbital 1.7 eye diameter. Mouth horizontal, subterminal, cleft reaching to below anterior margin of eye. Lower jaw subterminal, slightly shorter than upper, not included. Teeth simple, small, only slightly prominent, in 24–25 rows of up to 8–9 teeth anteriorly. In ventral view when upper lip is moved, margins of upper tooth plates visible. Diastemae absent. Lower jaw tapering anteriorly, chin rounded, deep. Lower jaw below oral cleft deep. Circumoral pores small, contoured; chin pores longitudinally-oval, interspace unpigmented, equal to their diameter, not in a pit but with thin skin fold anteriorly. Distance between nasal pores  $\frac{2}{3}$  eye diameter. Gill opening short, 0.8 eye diameter, its dorsal end horizontal with upper margin of eye, ventral end slightly below level of lower margin. Gill opening not vertical, its dorsal end in front of its ventral end. Opercular flap rounded, covering  $\frac{3}{4}$  of gill opening, its tip level with upper margin of pupil.

Uppermost pectoral ray horizontal with lower margin of eye, upper lobe not reaching anal-fin origin. P 18+1+4, rudimentary rays absent. Lowermost ray inserted behind vertical through posterior margin of eye. Skin of proximal side of upper lobe attached at about  $\frac{1}{4}$  distance from fin base to ray tips, in notch almost to tips, in lower lobe about  $\frac{1}{3}$ . Radials 3+1, R2 largest; R2 and R3 with tiny rudimentary notches. Three rudimentary fenestrae present. Scapula with rudimentary notch; helve short, with upper lateral rib. Helve of coracoid long, with two ribs.

Body elliptic, shallow, maximum depth at anterior of dorsal fin. Upper and lower body profiles are similarly curved. Tail quite deep anteriorly, posterior half rather thin. Horizontal midline of body passes below eye. Anterior



**Figure 28.** *Paraliparis brunneus* n.sp. A, holotype, CSIRO H749-05, ♀, 169 mm TL, 151 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 741, cleared and stained right pectoral girdle.

halves of dorsal and anal fins entirely embedded in gelatinous tissue, entirely covered by fin membrane, tips of rays not projecting. Anterior two dorsal rays short. Interneural of first dorsal ray between neural spines 5 and 6, two free interneurals present anteriorly between neural spines 3, 4, 5. Vertebral column almost completely straight anteriorly. Haemal spine of vertebra 11 short, about half as long as next. Epineural ribs on vertebrae 2–15, thin, as long as 3 vertebrae. Epipleural ribs on vertebrae 3–18, shorter than epineurals, as long as two vertebrae. Slight keel-like ridge above anterior half of pectoral fin present on side of body. Vertical fins overlapping caudal almost to its midpoint. Anus about below middle of postorbital space. Skin quite thick, prickles absent. Subcutaneous gelatinous layer moderately developed. Pyloric caeca similar. Eggs unripe.

**Colour.** Head and body uniformly dark, blackish-brown, lips slightly paler than head. Subrostral fold black, densely dotted inside. Mouth black, tongue densely black-dotted, tooth plates pale, gill arches densely dotted, almost black, branchial cavity black. Pores at least on lower jaw whitish, contrasting with dark skin. Peritoneum black, stomach and pyloric caeca pale.

**Distribution.** West coast of Tasmania, 1000–992 m.

**Etymology.** From the Latin *brunneus*, brown, in reference to the dense brown colour of the body.

**Comparative notes.** *Paraliparis brunneus* belongs to group IIIc and is most similar to *P. auriculatus* and *P. atrolabiatus* in having uniform black-brown colour, 3+1 radials and 3 rudimentary fenestrae in pectoral girdle, whitish contoured

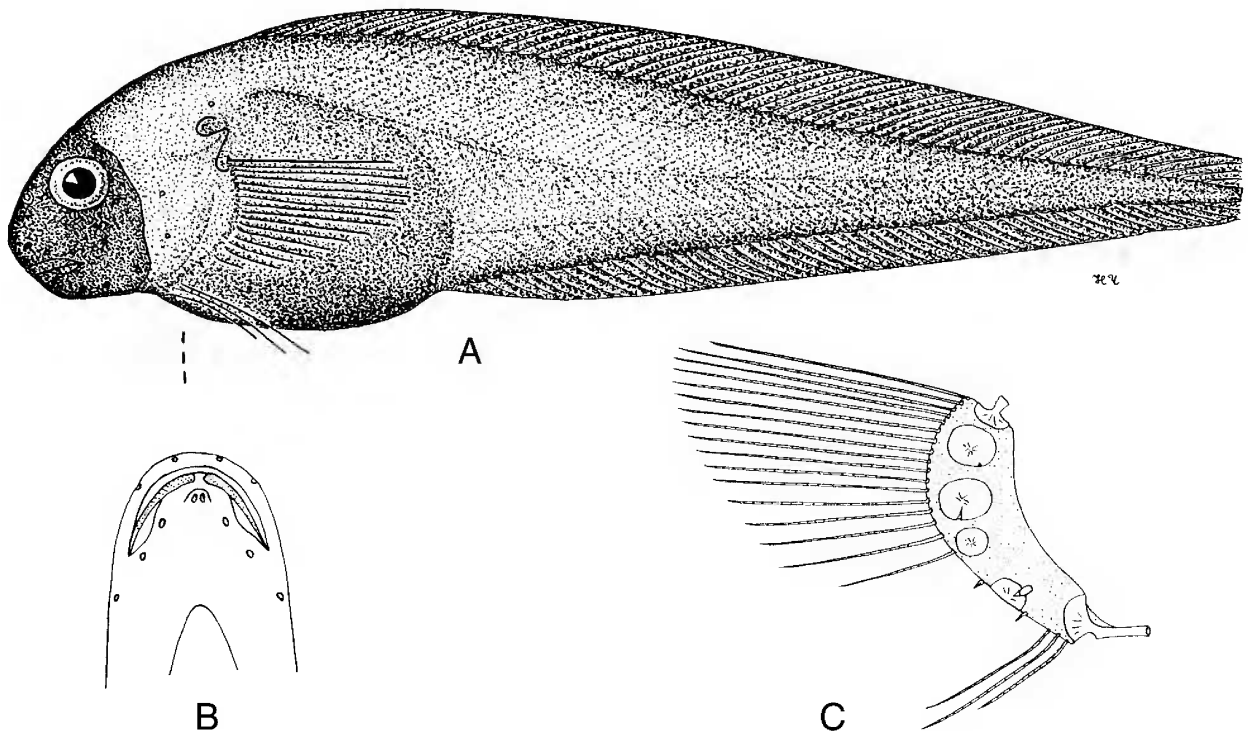
pores on the lower jaw, and the pectoral-fin upper lobe inner side free for  $\frac{3}{4}$  of its length. *Paraliparis brunneus* differs from *P. auriculatus* in having a longer snout (v. very slanted, almost absent in lateral view), radials 3+1 (v. 3+0), 3 rudimentary fenestrae (v. 2) in pectoral girdle, and anus located below mid-postorbital space (v. below gill opening). It differs from *P. atrolabiatus* in its dark, blackish-brown colour (v. lighter, brown with yellowish head), radials 3+1 (v. 2+0+0) fenestrae 3 (v. absent), P 18+1+4 (v. 16+2+3), and nephrohaemal canal absent (v. present).

***Paraliparis coracinus* n.sp.**

Fig. 29

**Material examined.** HOLOTYPE CSIRO H1935-02, ♀, unknown TL (tail missing), 170+ mm SL. FRV *Soela*, stn. So 1/89/56, 37°34.53'S 138°57.00'E, off South Australia, W of Cape Martin, 1205–1175 m, 1 Feb. 1989; radiograph 682 E2; pectoral girdle 795.

**Diagnosis.** Vert. 62+ (11+51+), D 54+, C unknown, radials 4, the lowest half-moon shaped, forming part of posterior margin of basal cartilaginous lamina. Mouth subterminal, lower jaw included. Teeth not large, simple. Chin pores touching each other, anterior skin fold present. Subrostral fold absent. Gill opening reaching ventrally in front of 4th pectoral ray. Ventral end of gill opening and uppermost pectoral ray on horizontal with upper margin of pupil. Pectoral fin 16–17+2r+3, two notch rays rudimentary. Head less than 20% SL, eye large, 27.0% HL, snout short, deeply rounded. Body deep, about 1.3 HL, slight costal ridge present. Head black, peritoneum black.



**Figure 29.** *Paraliparis coracinus* n.sp. A, holotype, CSIRO H1935-02, ♀, unknown TL, 170+ mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 795, cleared and stained right pectoral girdle.

**Further description.** Counts: D 54+, A 50+, P 21–22, C unknown, Vert. 62+(11+51+), radials 4 (3+1), one fenestra present; pc 5, gr 8, pores 2-6-7-1. Ratios: HL less than 20% SL; head width 54% HL, its depth 88, bd c. 132, bdA 100, preD 129, preA 176, ma 65, aAf 117, UPL 66, LPL damaged; sn 29.4, E 27.0 (measured between the edges of the retina), po 53, io 39.7, so 17, gs 20.6, uj 47.6, lj 42.3, pc 33.

Head slightly less than 20% SL, deep, compressed, depth 1.6 its width. Dorsal contour greatly rounded from deep occiput to snout tip, ventral profile straight. Eye very large, 3.7 in head, almost entering upper contour of head. Suborbital space about  $\frac{2}{3}$  eye diameter. Pupil about half eye diameter; interorbital 1.4 eye. Snout comparatively short, deeply rounded, its length from symphysis of upper jaw to anterior margin of eye equal to the latter. Snout most prominent on level with lower margin of eye. Subrostral fold absent, upper lip entirely visible; lower lip fold covered by upper lip. Nostril pore-like, level with lower margin of pupil. Mouth subterminal, oral cleft reaching to below eye centre, posterior of upper jaw extending to below posterior margin of pupil. Lower jaw shorter than upper, included. Upper tooth plates entirely visible in ventral view. Teeth simple, not large, in 27–32 rows of up to 9–10 teeth anteriorly. Teeth at distal ends of rows (anterior edge of tooth plates) tiny; interior teeth larger, especially in upper jaw. Diastema of upper jaw wide, in lower jaw narrower. Lower jaw below mouth cleft deep; chin skinned, honeycomb tissue clearly visible, well developed. Circumoral pores not large, chin pores touching, interspace unpigmented, a thin anterior skin fold present. Gill opening short, 0.7 eye diameter, its dorsal end above eye level, ventral end on level with ventral end on level with pupil, reaching ventrally to 4th pectoral ray. Opercular flap triangular, sharp-angled, its upper side deeply notched, covering  $\frac{2}{3}$  of gill opening.

Uppermost pectoral-fin ray level with upper margin of pupil. Upper lobe not reaching to anal-fin origin. P 16+2+3 (L), 17+2+3 (R); both notch rays rudimentary. Base of lower lobe rays quite far posterior, below last quarter of postorbital space. Ends of lower lobe rays missing. Pectoral girdle very unusual, radials 3+1, two upper large, R2 with rudimentary ventral notch, R3 small, round. R4 unusual, in shape a half-moon (half-round, hoof-like), its straight side even with and forming posterior margin of cartilaginous basal lamina exactly between rudimentary notch rays, its rounded side notched. Interradial fenestrae absent, but one unusual fenestra present at anterior surface of notched R4.

Body deep (132% HL), maximum depth at beginning of dorsal fin; upper contour of body abruptly rounded anteriorly. Ventral contour of body almost straight, dorsal very curved. Anterior dorsal and anal rays entirely embedded in gelatinous tissue. Parapophyses of vertebra 11 form a short haemal spine, absent on others. Interneural of first (rudimentary) dorsal ray between neural spines 5 and 6, 1 free anterior interneural present. Epineural ribs present on vertebrae 2–13, epipleural ribs on 3–25, length of anterior ribs of both series not longer than 3 vertebrae, but stout; a slight costal ridge present. Anus below posterior third of postorbital space. Ovarian eggs at different stages of maturity, largest 2.8 mm. Body partially skinned. Skin on head without prickles, dense, opaque. Subcutaneous gelatinous tissue moderately developed. Pyloric caeca of similar lengths.

**Colour.** Body partially skinned, reddish-brown shreds of dermis remain on muscles. Remnants of skin on head ink-black, body probably the same colour. Lips lighter, dark grey, mouth dark grey, tongue grey-dotted, tooth plates dark. Branchial cavity ink-black, gill arches grey. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** Off South Australia in the Great Australian Bight at about 1200 m.

**Etymology.** *Coracinus*, Latin, meaning jet-black.

**Comparative notes.** *Paraliparis coracinus* belongs to group IIIc, and is so distinctive we have no reluctance in describing it as new. It is particularly noteworthy for its pectoral girdle, with two rudimentary rays and a hoof-like R4 between them, forming the posterior margin of the girdle at that point. This is similar to the arrangement in *P. hureaui* Matallanas, 1999, and *P. charcoti* Duhamel, 1992, which have pectoral girdles with both R3 and R4 hoof-shaped, both forming part of the posterior margin of the pectoral girdle. Other characters distinguishing this species from all others include the gill opening reaching to 4th pectoral ray (v. in all others no farther than the second ray), absence of subrostral fold, large eye (27% HL), chin pores touching, and honeycomb tissue on the chin.

#### *Paraliparis costatus* n.sp.

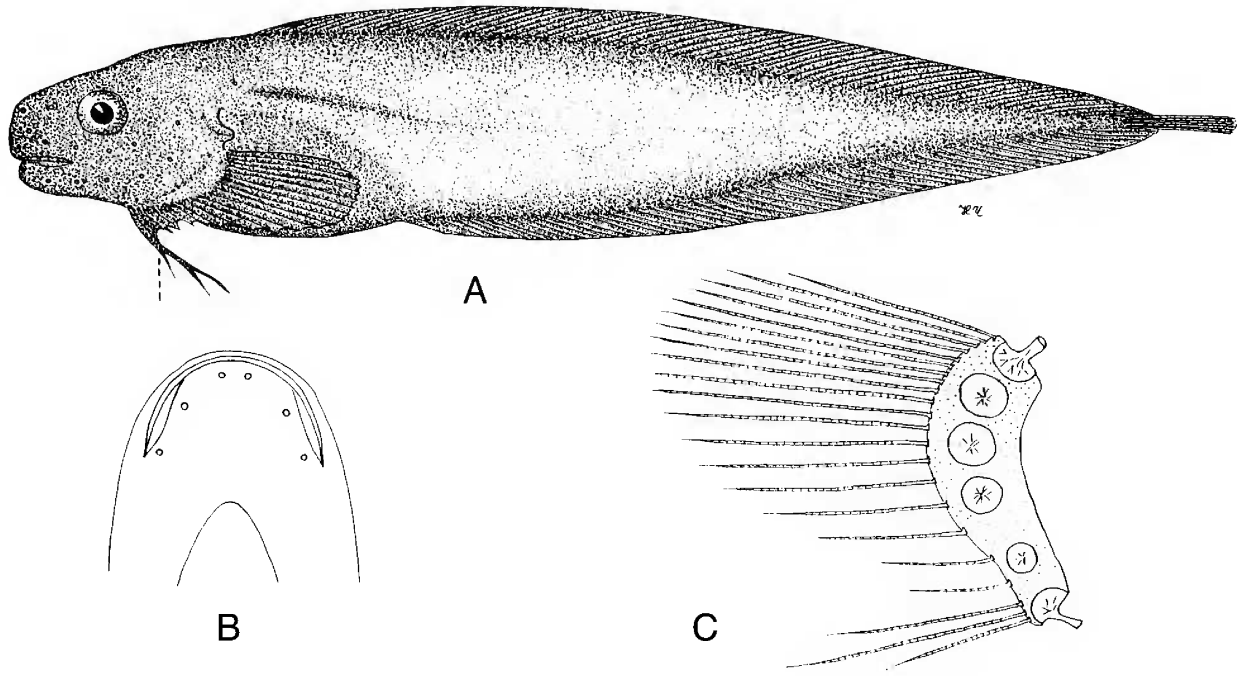
Fig. 30

**Material examined.** HOLOTYPE CSIRO H561-02, ♂, 224 mm TL, 204 mm SL. FRV *Soela*, stn. So 3/86/33, 41°51.4'S, 144°23.8'E, W coast of Tasmania, W of Granville Harbour, 1366–1370 m, 16 May 1986; radiograph 684A; pectoral girdle 733. PARATYPE CSIRO H1378-01, ♀, 261 mm TL, 235 mm SL. FV *Petuna Endeavour*, Stn 101/18, 42°12'S, 144°38'E, W coast of Tasmania, W of Cape Sorell, 1042–1080 m, 21 Apr. 1988; radiograph 684B; pectoral girdle 731.

**Diagnosis.** Vert. 70–71, D 62–66, P 22–24, C 8, radials 4, round. Snout high, blunt, and large; nasal pores widely spaced, chin pores not in a pit and without skin fold anteriorly. Mouth horizontal, terminal. Anterior 7–8 epineural and epipleural ribs straight, elongated, thickened. Keel-like lateral ridge protruding along and above anterior part of abdominal cavity. Gill opening lower end below eye level. Head 19.3–19.8% SL, preA length about 40, aAf 22–26% SL. Body black; orobranchial cavity black-dotted to black; peritoneum black.

**Further description.** Counts: D 66 [62], A 57 [56], P 22 [24], C 8 in both (1+3/3+1), Vert. 71 [70] (11+59–60), radials 4 (3+1), pc 5 [3], gr 10 [8]. Ratios: head 19.8 [19.3], its width 12.9 [12.7], and depth 13.8 [18.7], bd 16.2 [23.4], bdA 16.3 [19.6], preD 25.1 [28.5], preA 39.1 [40.3], ma 14.0 [12.8], aAf 21.7 [26.4], UPL 13.2 [12.7], LPL 11.8 [10.8], E 4.7 [4.7], sn 6.7 [7.4], gs 3.6 [4.5], io 9.8 [10.6], po 9.8 [10.6], so 2.9 [—], uj 9.6 [9.2], lj 9.1 [9.2], pc 5.3 [5.5]; as % HL: UPL 66.8 [65.6], E 23.8 [22.0], gs 19.5 [21.0], sn 36.6 [35.0], so 15.6 [—], io 54 [50], uj 48.3 [47.8], lj 44.6 [47.6].

Head small, not as deep as body, moderately compressed; its width 0.7 [0.6] HL and depth 1.1 [1.4] its width. Dorsal contour of head only slightly sloping to nearly vertical, deep, bluntly rounded snout, slightly protruding anterior to upper



**Figure 30.** *Paraliparis costatus* n.sp. A, holotype, CSIRO H561-02, ♂, 224 mm TL, 204 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 733, cleared and stained right pectoral girdle.

lip. Subrostral fold deep, partially covering upper lip. Interorbital space flat or a little convex, 1.7 [1.7] eye diameter. Mouth terminal, horizontal; lower jaw sub-terminal. Mouth cleft extending to below anterior of orbit, maxilla reaching to below mid-eye; teeth simple, small, subconical, closely set in about 30 oblique rows of up to 8–10 teeth each anteriorly, forming moderately wide bands in both jaws. Diastemae present in both jaws, that in lower wider than in upper; lower jaw long, about  $\frac{1}{2}$  HL. Eye moderately large, 4.2 [4.1] eye diameter, well below dorsal outline of head. Suborbital space  $\frac{2}{3}$  eye. Nostril with low raised rim, level with upper margin of pupil. Pupil half eye diameter. Circumoral pores small, round; chin pores well spaced, interspace between them ( $pm_1$ – $pm_1$ ) equalling two pore diameters, pigmented. Nasal pores unusually widely spaced, the lower just above upper lip, the upper at the top of snout; distance between them equals eye diameter. Gill opening completely above pectoral-fin base; its upper end level with upper margin of pupil, lower end level with middle of suborbital space; opercular lobe small, roundly pointed, on horizontal with lower margin of eye.

Uppermost pectoral ray level with middle of suborbital space, lowermost ray inserted below posterior margin of eye. In the holotype P 22 (15+4+3), in the paratype 24 (16+4+4). Upper pectoral lobe rather short, not reaching anal-fin origin. Pectoral-fin notch moderately deep, dividing fin into two distinct lobes. Notch rays 3–4, shortened gradually ventrally but not becoming rudimentary; more widely spaced in notch but more closely spaced dorsally, difficult to distinguish from upper lobe rays. Lower lobe short, of 3–4 rays, slightly shorter than upper lobe. Skin on proximal surface attached at bases of all rays. Pectoral girdle morphology identical in both specimens: radials 4 (3+1), round, rather large, rudimentary fenestrae absent. Scapula and coracoid with well-developed shafts; additional side ribs absent. Coracoid without opening.

Body elliptical, relatively slender, maximum depth at

anal-fin origin, 6.6 in SL, less than HL (0.8). Anterior dorsal-fin rays rudimentary. Interneural of first dorsal ray between neural spines 5 and 6, one free interneural present anteriorly, between 4th and 5th neural spines. Epineural ribs present on 2nd–16th, epipleural ribs on 2nd–15th vertebrae, anterior ones short, but on vertebrae 4–7 longer, straight, thickened in the middle (up to 3–4 vertebrae long); becoming gradually shorter caudally, discernible up to vertebrae 13–16. A keel-like costal ridge present above and along anterior part of abdominal cavity. Horizontal midline passes through lower margin of eye. Caudal fin of 6 principal rays, a single procurrent ray present above and below (1+3/3+1), overlapped by dorsal and anal fin rays to one third of its length. Anus below middle of postorbital space, preA long. Skin thin, semitransparent; subcutaneous gelatinous layer moderately developed. Pyloric caeca wide, similar. Urogenital papilla in male short, conical, below  $\frac{3}{4}$  postorbital space. Female (paratype) with three generations of oocytes, largest of 3.2 mm diameter (its belly enlarged because of eggs so body depth much larger than in male holotype).

**Colour.** Skin black, head and belly darker than body of which pale muscles are visible through skin. Subrostral fold of the same colour as head, lips dark grey. Mouth and tongue grey, tooth plates pale. Pores whitish, distinctly contrasting with head colour. Branchial cavity dark-dotted to black, gill arches dark-dotted, peritoneum black, stomach pale, pyloric caeca and posterior part of intestine grey.

**Distribution.** West coast of Tasmania between 1042–1370 m.

**Etymology.** The specific epithet is formed from the Latin word *costa*, rib, to emphasize the unusual development of epineural and epipleural ribs in this species.

**Comparative notes.** *Paraliparis costatus* is in group IIIa. It has well-developed epipleural and epineural ribs forming a keel-like lateral ridge above the pectoral fins, a large, blunt,

deep snout with widely spaced nasal pores, 4 round radials, maximum body depth at anal-fin origin, and pale circumoral pores. The paratype (a ripe female) differs from the holotype (unripe adult male) in having a deeper head and body [hd 86, bd 110% HL] owing to having ripe ovarian eggs. The ratio of head depth to width is 1.5 v. 1.0. The teeth also appear stronger and stouter, the diastemae are wider, and the remnants of the skin on the body have a reddish tint. *Paraliparis costatus* differs from nearly all *Paraliparis* (with the exceptions of *P. dewitti*, *P. lasti*, and *Paraliparis* sp. 2) in the unusually well-developed ribs forming a costal ridge. See description of *P. dewitti* for comparison. *Paraliparis costatus* differs from *P. lasti*, which has similar chin pores, by its black (v. reddish-brown) colour, more ventral gill opening (lower end below eye v. level with eye centre), and radials 3+1 (v. 3+0).

*Paraliparis csiroi* n.sp.

Fig. 31

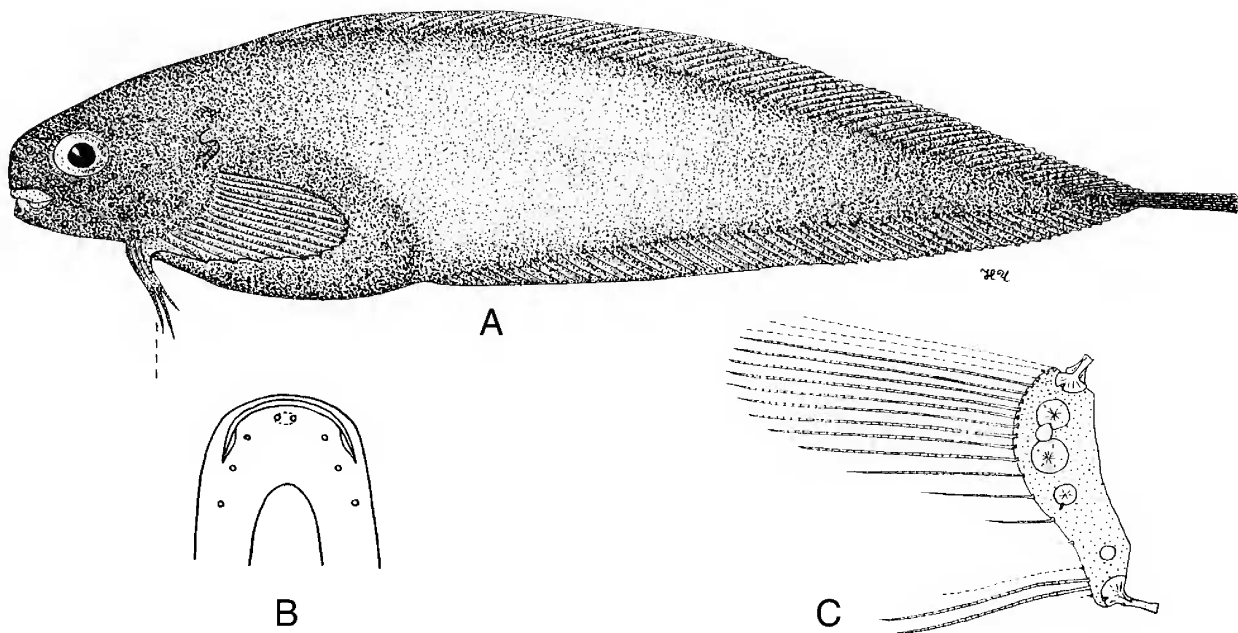
**Material examined.** HOLOTYPE NMV A5874, ripe ♀, 182 mm TL, 163 mm SL. FRV *Soela*, stn. 01/88/86, 38°37.58'S 141°01.12'E, 60 km S of the Victoria-South Australia border, 1080–1110 m, 8 Feb. 1988; radiograph NMV A5874; pectoral girdle 739.

**Diagnosis.** Vert. 66, D c. 60, C 8, radials 3, uppermost ventrally notched. Parapophyses of vertebrae 5–11 fused to form a nephrohaemal canal. Pectoral fin 20 (15+1+4), one rudimentary ray each present in notch and in lower lobe. Mouth terminal, short. Chin pores separated by one pore diameter, in a common oval, pigmented depression on anterior surface of chin. Gill opening ventral end horizontal with lower margin of pupil. Head compressed, HL 19.6% SL, preanal 39% SL. Colour dark brown, lips light grey, peritoneum black, mouth and tongue grey.

**Further description.** Counts: D c. 60, A c. 55, P 20 (15+1r+4=3+1r), C 8 (4/4), Vert. 66 (11+55), radials 3 (3+0, see below), pc 5, gr 8, pores 2-6-7-1. Ratios: HL 19.6, its width 10.7 (54) and depth 17.4 (88), bd 24.6 (125), bdA 21.5 (109), preD 25.1, preA 38.7, ma 13.9, aAf 24.6, UPL 13.9 (70), LPL 9.8 (85% HL, 71% UPL), E 4.6 (23.4), gs 3.3 (17.1), sn 6.4 (32.8), po 10.4 (53), so 2.6 (13.4), uj 9.2 (46.8), lj 6.7 (34.4), io 6.1 (31.3), pc 4.6.

Head small, 5.1 in SL, strongly compressed and deep, depth 1.6 its width. Dorsal contour gradually sloping anteriorly to highest point of snout; snout deep and blunt, not projecting anterior to upper jaw. Distance from upper jaw symphysis to eye 1.4 eye. Subrostral fold absent, upper lip not covered. Eye 4.3 in HL, its upper contour far below dorsal contour of head, distance from lower margin of eye to mouth very short, about equal to 0.6 eye diameter. Pupil slightly larger than half eye diameter. Interorbital narrow, 1.3 eye. Nostril with raised rim, horizontal with upper half of pupil. Mouth horizontal, terminal, oral cleft reaching to below anterior margin of eye. Lower jaw included, in ventral view broadly rounded anteriorly, but in lateral view, symphysis in reverse angle so that it slopes anteroventrally; depth shallow below posterior of oral cleft. Teeth simple, small, only slightly projecting, with blunt tips, in 23–24 regular rows, curved on the anterior surface of tooth plates; c. 11 teeth in each anterior row. Diastema of upper jaw slightly narrower than that of lower jaw. Circumoral pores small; chin pore interspace equal to pore diameter, pigmented, in a common oval depression located on anterior surface of gelatinous chin. Gill opening vertical, short, 0.7 eye diameter, entirely above base of upper P ray; opening vertical; its upper end slightly above horizontal through upper margin of eye, ventral end level with lower margin of pupil. Opercular flap small, ear-shaped, dorsally notched; its tip about level with upper margin of eye.

Base of upper pectoral ray below end of opercular flap, level with lower margin of pupil; lowermost ray inserted



**Figure 31.** *Paraliparis csiroi* n.sp. A, holotype, NMV A5874, ripe ♀, 182 mm TL, 163 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 739, cleared and stained right pectoral girdle.

behind vertical through posterior margin of eye. P 15+1 (rudimentary)+ 3 (and 1 rudimentary), deeply notched, rudimentary notch ray clearly seen only with clearing and staining; upper and lower lobes united by pectoral-fin membrane; lowermost lower lobe ray also rudimentary. Upper lobe rays not nearly reaching anal-fin origin, lower lobe long, length c. 70% UPL. Pectoral-fin skin missing. Pectoral radials 3 (3+0). The 4th (lowest) radial is probably undeveloped, a distinctly contoured round opening present at normal radial location. Upper radial with ventral notch, others unnotched. One fenestra (f2) present below upper radial, two small rudimentary slit-like openings present below scapula and third radial. Helve of scapula with two lateral ribs, coracoid with long thin unribbed shaft. Anteroventral part of basal cartilaginous lamina above coracoid slightly angled, not joined to cleithrum (the latter not visible in Fig. 31b).

Body deep, leaf-like, greatest depth above posterior half of abdomen, 4.1 in SL; depth above A exceeds head length (109%). Dorsal contour gradually rounded anteriorly and posteriorly. Horizontal midline passes through eye centre. Anterior dorsal rays gradually lengthening posteriorly, embedded in gelatinous tissue. First dorsal ray rudimentary, its interneural between neural spines 4 and 5, a free interneural present between spines 3 and 4. First anal ray on vertebra 11, below dorsal ray 7. Parapophyses of vertebrae 5–11 joined to form short spines, forming a nephrohaemal canal; spines 5–7 directed anteroventrally; haemal spine of posteriormost abdominal vertebra (11) about 1/3 length of haemal spine of first caudal vertebra. Epineural ribs on vertebrae 3–14, epipleural ribs on vertebrae 3–18, all thin, not long, lengths of anterior 7–8 not longer than 2–2.5 vertebrae. Anus below midst of postorbital space. Caudal fin overlapped by vertical fins about 1/2 of its length. Skin thin, slightly transparent; prickles absent; subcutaneous gelatinous tissue moderately developed. Pyloric caeca with wide bases and sharp tips, of similar size. Almost ripe eggs c. 4.1 mm in diameter.

**Colour.** Head and body dark blackish-brown, body lighter than head and caudal; lips and chin margin light grey. Chin pore depression pigmented, pores as dark as head. Anal region black. Mouth grey, tongue dark grey, branchial cavity greyish-brown. Peritoneum black, stomach and pyloric caeca pale.

**Distribution.** Off South Australia at 1080–1110 m.

**Etymology.** Named after the Commonwealth Scientific and Industrial Research Organization (CSIRO), the supporting agency for Australian fisheries research.

**Comparative notes.** *Paraliparis csiroi* belongs to group IIIb, and is distinguished by its nephrohaemal canal, low eye (suborbital space about half eye diameter), narrow interorbital, rudimentary single notch ray, deep body (125% HL) with maximum depth in posterior of abdomen, blunt, short, snout, short mouth, subrostral fold absent, chin pore depression on anterior surface of gelatinous chin (a unique character), and lips paler than head. In group IIIb, it is most similar to *P. australiensis*, which also has no normally developed rays in the pectoral-fin notch, but differs from it in the absence of foramina in the pectoral girdle (*v.* present), lower eye (*v.* touching upper contour of head), chin-pore

pit on the anterior surface of the chin (*v.* on lower surface), anus below middle of postorbital head (*v.* just below rear of eye), nephrohaemal canal (*v.* absent), absence of the subrostral fold (*v.* deep, almost entirely covering upper lip), and body paler than head and caudal (*v.* the same). It is also similar to *P. atrolabiatus*, but in addition to the above characters, differs in having 3+0 radials (*v.* 2+0+0), one fenestra in the pectoral girdle (*v.* none), and head darker than body, blackish - brown (*v.* head lighter than body, yellowish-brown).

### *Paraliparis delphis* n.sp.

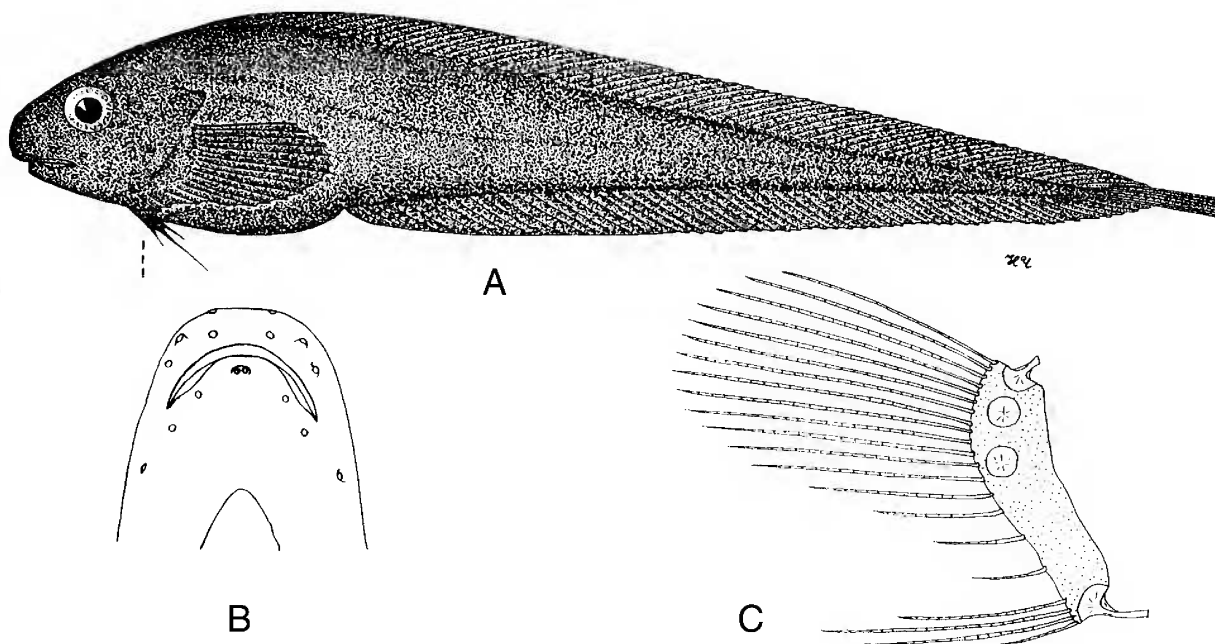
Fig. 32

**Material examined.** HOLOTYPE CSIRO H749-03, ♂, 140 mm TL, 127 mm SL. FRV *Soela*, So 3/86/32, 41°45.8'S 144°24.8'E, W coast of Tasmania, W of Granville Harbour, 1000–992 m, 16 May 1986; radiograph 680 F 3; pectoral girdle 791.

**Diagnosis.** Vert. 67, D 61, C 8, radials 2, round. Mouth subterminal, lower jaw included, teeth simple, small. Chin pores almost touching, not in a pit but with thin skin fold anteriorly, interspace unpigmented. Lower end of gill opening and uppermost pectoral-fin ray horizontal with pupil. Opercular flap triangular with rounded end. P 15+2+4, rudimentary rays absent. Nephrohaemal canal present on vertebrae 5–11. HL 18% SL, preA 31%. Colour very dark, uniformly brownish-black, mouth grey, tongue grey-dotted, peritoneum black.

**Further description.** Counts: D 61, A 53, P 21 (15+2+4), C 8 (4/4), Vert. 67 (11+56), radials 2+0+0, gr 8, pc 6, pores 2-6-7-1. Ratios: HL 18.1, its width 11.0 (61) and depth 15.0 (83), bd 16.1 (89), bdA 15.0 (83), preD 21.2, preA 31, ma 12.0, aAf 20.4, UPL 13.0 (71), LPL 11.0 (85% UPL), NL 2.2 (17% UPL), E 4.4 (24.3), gs 3.2 (17.8), sn 6.0 (33.0), po 8.8 (49), io 7.6 (41.7), so 3.1 (17.4), uj 8.3 (45.7), lj 7.7 (43.5), pc 5.5–7.0.

Head small, 5.5 in SL, not very compressed, depth 1.4 its width. Dorsal profile deep at occiput, slanting anteriorly to rounded snout. Eye not touching dorsal profile of head, suborbital distance about 0.7 eye. Pupil equals about half eye diameter. Interorbital width 1.6 eye. Snout deep, rounded, clearly projecting; gelatinous, 1.4 eye, its dorsal edge level with lower margin of pupil. Nostril pore-like, horizontal with lower margin of pupil. Subrostral fold deeper anteriorly than laterally, where upper lip clearly visible. Mouth horizontal, subterminal (almost inferior, but lower surface of head slanted, not horizontal), cleft almost reaching to below anterior margin of pupil. Lower jaw included; in ventral view, upper tooth plates entirely visible anteriorly when upper lip is turned out; nasal and two anterior infraorbital pores also visible. Teeth simple, small, only slightly prominent, in about 21–24 regular oblique rows of up to 11 and 9 teeth each anteriorly in both jaws. In upper jaw, rows extend as very small teeth onto anterior surface of tooth plate. Diastemae not clearly developed. Lower jaw below end of mouth cleft deep. Circumoral pores small, with raised rims. Chin pores closely set, interspace less than their diameter, unpigmented, even with chin surface but with a thin, pigmented, skin fold anteriorly. Gill opening short, dorsal end slightly above eye, ventral end about level with eye centre. Gill opening not vertical, dorsal end slightly anterior to ventral end. Opercular flap triangular, rounded ventrally,



**Figure 32.** *Paraliparis delphis* n.sp. A, holotype, CSIRO H749-03, ♂, 140 mm TL, 127 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 791, cleared and stained right pectoral girdle.

dorsally unnotched, tip level with upper margin of eye.

Uppermost pectoral ray level with lower margin of pupil, base of ventralmost ray on vertical just behind posterior margin of eye. Skin closely attached to body, covering anterior  $\frac{1}{4}$  of upper lobe, only posterior of fin free and movable; lower fin lobe similar, about  $\frac{1}{3}$  attached; notch rays about 80% attached, free parts of upper and lower lobes appear to be separate, unjoined by fin membrane. Upper pectoral lobe not reaching to anal-fin origin. P 15+2+4, lowermost notch ray short, 17% UPL, but not rudimentary. Radials 2+0+0, round, fenestrae absent. Coracoid with a long thin helve.

Body not deep, distinctly humpbacked, greatest depth 89% HL, at first dorsal-fin ray. Ventral contour of body almost straight, dorsal contour much curved at dorsal-fin origin. Horizontal midline of body passes through centre of eye. Preanal distance short, 31% SL. Interneural of first dorsal ray between neural spines 4 and 5; one free anterior interneural present. Anterior of dorsal fin covered by gelatinous tissue. Parapophyses of vertebrae 5–11 joined, forming nephrohaemal canal. Costal ridges weakly developed. Epineural ribs on vertebrae 3–16, short, thin, not as long as two vertebrae; epipleural ribs on vertebrae 5–11, also slim. Vertical fins overlapping anterior half of caudal. Anus below middle of postorbital space. Gelatinous tissue moderately developed. Skin quite dense, opaque, prickles absent. Pyloric caeca elongated. Small, cone-like, urogenital papilla present.

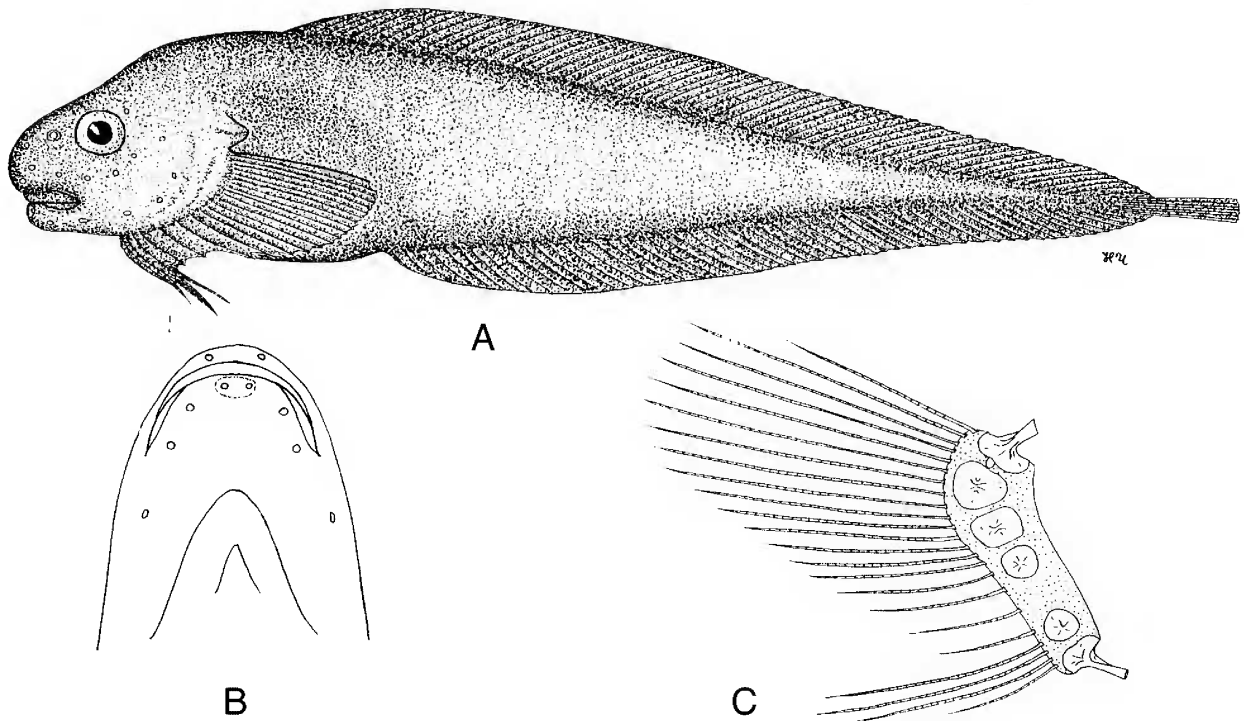
**Colour.** Head, lips, chin, and body uniformly dark, brownish-black. Mouth dark grey, slightly lighter than head, tongue grey-dotted. Inner surface of subrostral fold as dark as head, densely black-dotted. Branchial cavity and gill arches dark grey. Pores paler inside but not strongly contrasting with head colour. Peritoneum black, stomach and pyloric caeca pale. Urogenital papilla black.

**Distribution.** West coast of Tasmania, 1000–992 m.

**Etymology.** The name is derived from the Greek *delphis*, dolphin, to which the new species is similar in body shape.

**Comparative notes.** *Paraliparis delphis* belongs to group IIIc. It is distinguished by its hump-backed body, very dark uniform brownish-black colour, round radials 2+0+0, nephrohaemal canal on vertebrae 5–11, and chin pores touching with a very narrow unpigmented interspace. It is most similar to *P. atrolabiatus* and *P. ater*, but differs from the former in its very dark, uniform, brownish-black colour (v. non-uniform, brown, light-yellowish head and blackish pectoral fin, opercular flap and genital papilla), lips similar to head colour (v. darker than head, blackish), mouth dark grey but lighter than head (v. dark grey and darker than head), body more hump-backed and slightly shallower (bd 89 v. 95% HL, bdA 83 v. 91%), anus below middle of suborbital space (v. below first third), first dorsal interneural between neural spines 4 and 5 (v. 6 and 7), one free interneural (v. 2), nephrohaemal canal on vertebrae 5–11 (v. 3–11), lower jaw included (v. subterminal), chin pores almost touching (v. spaced by 2 diameters), triangular opercular flap with rounded tip and unnotched upper edge (v. rounded), and a longer lower pectoral lobe of 85 (v. 61% UPL). It differs from *P. ater* in having 2+0 radials (v. 3+0), shape of opercular flap, preanal length 31 (v. 37), lower jaw included (v. subterminal), subrostral fold deep anteriorly (v. almost absent), and other characters.





**Figure 33.** *Paraliparis dewitti* n.sp. A, holotype, CSIRO T889-02, ♀, 213 mm TL, 192 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 742, cleared and stained right pectoral girdle.

***Paraliparis dewitti* n.sp.**

Fig. 33

**Material examined.** HOLOTYPE CSIRO T889-02, ♀, 213 mm TL, 192 mm SL. FV *Margaret Philippa*, 34°26.5'S 132°04'E, South Australia, Great Australian Bight, 1175–1118 m, 14 Nov. 1984; radiograph 684E; pectoral girdle 742.

**Diagnosis.** Vert. 65, C 8, radials 4, round; one rudimentary fenestra present. About 7 anterior epineural and epipleural ribs long, stout. Mouth horizontal, subterminal, teeth tiny. Chin pores in common wide-oval depression, interspace equals twice their diameter. P 22–23 (17+2+3–4), rudimentary notch rays absent. Prominent costal ridge present. Head 21% SL, wide (67% HL). Eye diameter half interorbital width. BdA 90% HL, preanal length 34% SL. Colour light nut-brown, skin semitransparent, peritoneum black.

**Further description.** Counts: D 59, A 52, P 22–23, C 8 (4/4), Vert. 65 (12+53), radials 4, pc 6, gr 11, pores 2-6-7-1. Ratios: HL 21.4, its width 14.3 (67) and depth 18.3 (86), bd 20.1 (93), bdA 19.3 (90), preD 24.5, preA 33.9, ma 14.1, aAf 19.5, UPL 13.5 (63), LPL 12.0 (56% HL, 88% UPL), NL 4.2 (31% UPL), E 4.1 (20.2), gs 4.1 (19.0), sn 7.8 (36.5), postocular 10.6 (49.8), io 8.9 (41.5), so 3.3 (15.6), uj 10.4 (48.8), lj 10.1 (47.6), pc 3.0.

Head moderately large, 4.7 in SL and wide, its depth 1.3 its width. Dorsal contour high at occiput, sloping anteroventrally from above eye. Snout large, 1.8 eye, comparatively deep, rounded in lateral profile, significantly projecting anterior to upper jaw. Subrostral fold shallow, not covering upper lip. Eye small, 4.9 in HL, upper margin not touching dorsal profile of head, suborbital space 0.8 eye. Pupil about half of eye diameter. Interorbital width

twice eye diameter. Nostril small, rim low, on horizontal with lower half of pupil. Mouth horizontal, subterminal, oral cleft reaching to below anterior margin of pupil. Lower jaw included. Chin below posterior of oral cleft deep. In ventral view, when upper lip pushed aside, margins of upper tooth plates visible; chin wide and blunt. Upper lip wide, lower lip fold distinct. Teeth simple, sharp, tiny, tooth plates appear smooth, in about 29–30 oblique rows of 10–13 teeth each anteriorly. Diastema of lower jaw narrower than in upper. Circumoral pores small, without thickened rims. Chin pores small, two pore diameters distant, interspace pigmented, in a shallow, wide, oval pit placed on the lower surface of the gelatinous chin. Gill opening 0.9 eye diameter, entirely above P fin base, slanted anteriorly, its upper end slightly above horizontal of upper margin of eye, lower end level with lower margin of pupil. Opercular flap small, triangular, tip level with upper margin of pupil. Gill rakers knob-like, prickles absent.

Base of uppermost pectoral-fin ray level with lower margin of eye, just below lower end of gill opening. Upper P lobe short, almost reaching anal-fin origin. Pectoral fin deeply notched, rays quite stout, length about 30% UPL. P 17+2+3–4. Lower lobe rays 3 or 4, lowermost ray inserted below posterior margin of eye. Pectoral radials rounded, 4 (3+1). One rudimentary fenestra present below scapula. Scapula and coracoid each with a long, strong shaft, with an upper lateral rib.

Body humpbacked, depth comparatively shallow (93% HL), deepest at D origin, depth at A origin similar. Horizontal midline of body passes through mid-eye. Skin thin, semitransparent. Subcutaneous gelatinous tissue moderately developed, anterior dorsal rays embedded. First dorsal ray interneural between neural spines 4 and 5, free interneurals absent. Parapophyses of two last abdominal

vertebra (11, 12) forming rather short haemal spines. Epineural ribs on vertebra 3–11, epipleural ribs on vertebra 3–18; anterior 7–8 epipleural and epineural ribs long and stout, about as long as 4 vertebrae. Ribs producing a prominent keel-like lateral ridge on each side of body above first half of pectoral fin. Vertical fins overlap caudal for about one fourth of its length. Anus below posterior third of postorbital space. Pyloric caeca short and quite thick, with rounded ends, of similar size. Eggs small, unripe.

**Colour.** Body uniformly light nut-brown (without reddish tint), skin semitransparent, showing pale musculature. Interspace between chin pores pigmented. Mouth and tongue light grey, inner surface of subrostral fold and pores same colour as head; lips and chin slightly lighter. Tooth plates pale. Peritoneum black, stomach pale, pyloric caeca grey. Branchial cavity dark greyish-brown, gill arches light brownish-grey.

**Distribution.** Off South Australia, Great Australian Bight, 1175–1118 m.

**Etymology.** Named in honour of Hugh H. Dewitt (1933–1995), prominent student of the Antarctic fish fauna.

**Comparative notes.** *Paraliparis dewitti* is a member of group IIIb. It is distinguished by having well-developed epineural and epipleural ribs, a costal ridge, 4 radials, wide head, large snout, tiny teeth, a large chin pore pit, and short upper pectoral-fin lobe and pyloric caeca. It is similar to *P. costatus*, but differs in lower counts: Vert. 65 (v. 70–71), D 59 (v. 62–66), A 52 (v. 56–57), C without procurrent rays, 4/4 (v. 1+3/3+1), one rudimentary fenestra in pectoral girdle (v. absent), coracoid with long helve (v. thin, small), chin pores in a wide oval depression (v. not), nut-brown colour (v. black), and other characters.

*Paraliparis eastmani* n.sp.

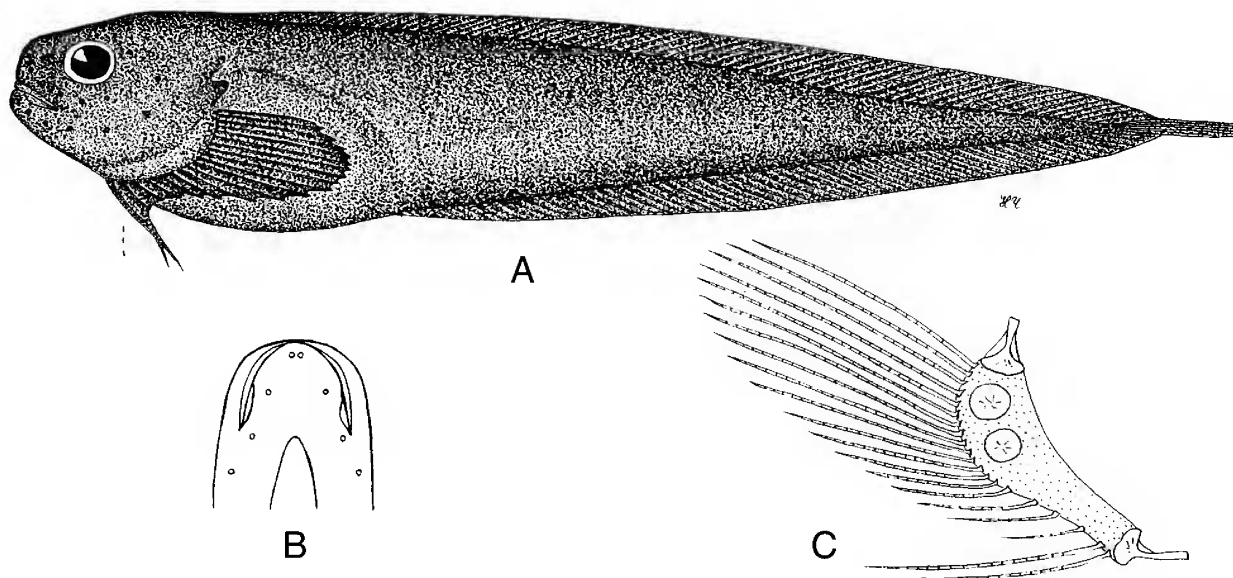
Fig. 34

**Material examined.** HOLOTYPE AMS I28900-003, ♂, 203 mm TL, 183 mm SL. FV *Kapala*, fld. no. K 88-17-06, 33°29.5'S, 152°12.5'E, E of Broken Bay, New South Wales, 1035–1070 m, 1 Sep. 1988; radiograph 28900; pectoral girdle 743.

**Diagnosis.** Vert. 69, D 64, P 20 (15+3+2), C 8, with 2 procurrent rays, radials 2, round. Mouth oblique. Teeth stout, subconical. Chin pores at surface, interspace equal to diameter. Gill opening small, 0.8 eye diameter, with dorsal end level with eye centre. HL 19.0% SL, preA 36%. Body depth equal to head length, bdA 90% HL. Skin thick, not transparent. Colour solid black, inner surface of subrostral fold and tooth plates black-dotted.

**Further description.** Counts: D 64, A 57, P 20, Vert. 69 (11+58), C 8 (1+3/3+1), radials 2 (2+0+0), pc 4. Ratios: HL 19.0, its width 9.3 (49.0), bd 18.5 (100), bdA 16.9 (89), preD 16.1, preA 36.0, ma 11.9, aAf 24.6, UPL 12.6 (66), LPL 12.1 (64.0% HL, 107% UPL), NL c. 3.2, io 8.2 (42.9), so 2.7 (14.4), E 4.9 (25.9), uj 9.7 (51.3), lj 9.2 (48.4), gs 3.9 (20.7).

Head small, greatly compressed, its width nearly half its length. Dorsal contour of head very slowly sloping to high, blunt, snout, not protruding anteriorly. Snout 1.2 eye diameter, its highest point level with upper margin of eye. Subrostral fold deep. Interorbital space gently curved, broad, 1.7 eye diameter. Eye large, 3.9 in head, very large pupil almost equal to eye diameter, dorsal margin of eye well below dorsal profile of head, suborbital distance 0.6 eye. Nostril with slightly raised rim, level with eye centre. Mouth oblique, terminal, large, lower jaw projecting. Posterior of mouth cleft nearly reaching vertical through anterior edge



**Figure 34.** *Paraliparis eastmani* n.sp. A, holotype, AMS I28900-003, ♂, 203 mm TL, 183 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 743, cleared and stained right pectoral girdle.

of eye. Teeth simple, stout, subconical, with blunted tips, closely set in 21 and 28 oblique rows in both jaws, 7–8 teeth in each row anteriorly. A wide diastema present at symphysis of upper jaw, that in lower jaw narrower; chin slanted. Chin below posterior of mouth cleft deep. Circumoral pores small, round, hardly discernible in black skin. Chin pores very closely set, interspace equals their diameter, not in a pit or skin depression. Opercular flap small, triangular, its tip level with lower half of eye, covering about  $\frac{2}{3}$  of gill opening. Gill opening very small, 0.8 eye diameter, vertical, completely above pectoral-fin base; its dorsal end level with eye centre, ventral end with middle of suborbital space.

Uppermost pectoral-fin ray origin about level with posterior end of oblique upper jaw. P 20 (15+3+2), deeply notched, its upper lobe of 15 rays, short, not reaching anal-fin origin. Notch rays three, moderately short, the shortest  $\frac{1}{3}$  the length of upper lobe rays. Lower pectoral lobe distinct, consisting of two elongate rays only; origin about at posterior margin of eye. Pectoral membrane of proximal fin surface attached to body at base of upper lobe, at about 70% of notch ray length, and at about 33% of lower lobe length. Basal cartilaginous lamina with two round radials, both located dorsally just below scapula; foramina absent. Scapula helve of unusual form, thin and comparatively long with additional lateral ribs. Coracoid without foramen, helve long.

Body moderately deep, elongated, its greatest depth at middle of pectoral upper lobe, equal to head length, bdA c. 90% HL. Dorsal contour of body straighter than ventral contour. Predorsal length short, interneural of first dorsal-fin ray between 4th and 5th neural spines; one free (rayless) interneural present anteriorly. Epineural ribs on 2nd–17th vertebrae, epipleural on 3rd–15th, thin and short, lengths equal to 1.5–2.5 vertebrae. Parapophyses of 10th–11th vertebrae joined, forming short haemal spines. Vertebral column without a curve anteriorly. Caudal fin of 6 principal rays; a single procurrent ray present above and below (1+3/3+1). Caudal fin about  $\frac{1}{3}$  overlapped by dorsal- and anal-fin rays. Anus below  $\frac{1}{3}$  of postorbital space. Skin thick, opaque, not loose. Pyloric caeca of similar size, short, about 4.6% SL. Gelatinous tissue not well developed.

**Colour.** Body uniformly solid black, palate black; tongue, inner surface of subrostral fold, branchial cavity, mouth between lower jaws, and tooth plates black-dotted. Stomach, pyloric caeca and intestine unpigmented. Peritoneum solid black.

**Distribution.** Tasman Sea a little north of Sydney, 1035–1070 m.

**Etymology.** The new species is named after Joseph T. Eastman in honour of his valuable studies on the natural history, physiology, and origins of the Antarctic fish fauna.

**Comparative notes.** *Paraliparis eastmani* belongs to group I. It is distinguished by its solid black colour, thick opaque skin, and short gill opening (equal to 0.8 eye diameter). It is most similar to *P. brunneocaudatus*, but differs in its black (v. reddish-brown) colour, absence of pectoral fenestrae (v. 2), projecting lower jaw (v. included), dark tooth plates (v. pale), and other characters. *Paraliparis eastmani* is similar to *P. trunovi* Andriashev from the Meteor Seamount and the slope of SE Africa (Andriashev, 1986) in having two dorsally located radials, a dark body and orobranchial cavity,

and especially in having two elongated lower pectoral-fin rays that are slightly longer than the longest upper pectoral-fin lobe rays. However, it differs distinctly in having a shorter head (19.0% SL v. 22.7–23.0), darker colour (uniformly solid black v. dark brown, unpigmented muscles visible through the skin), and fully developed notch rays (v. rudimentary). In addition, Vert. 69 (v. 63–66), D 64 (v. 57–59), A 57 (v. 51–53), and C 1+3/3+1 (v. 4/4).

### *Paraliparis gomoni* n.sp.

Fig. 35

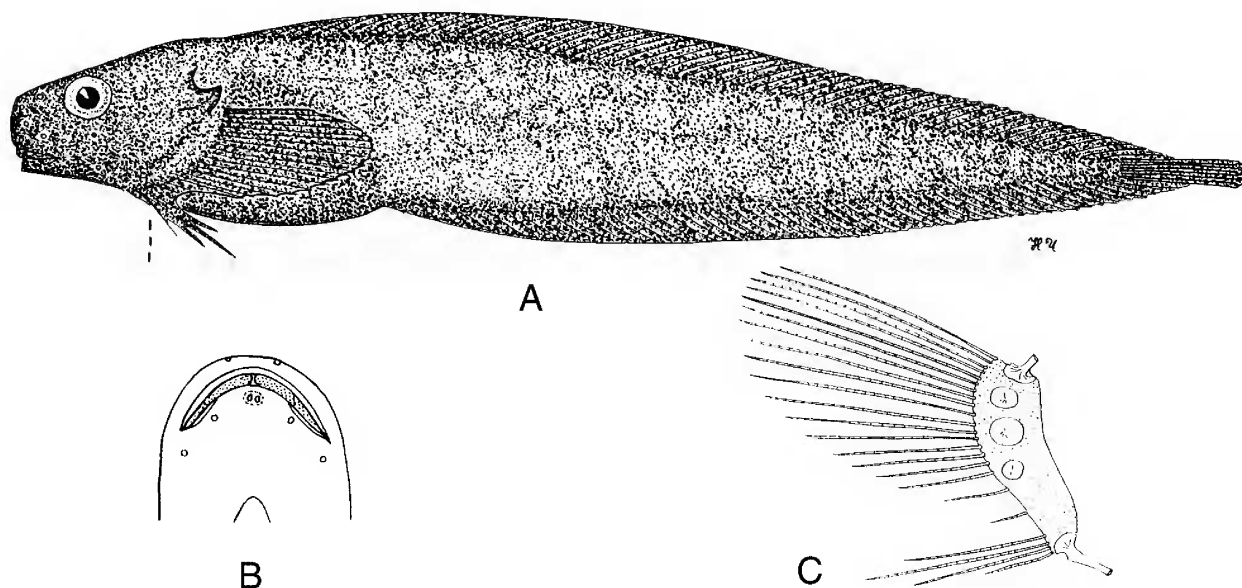
**Material examined.** HOLOTYPE NMV A7124, ripe ♂, 121 mm TL, 110 mm SL. FRV *Soela*, stn. So 3/88/8, 39°00.92'S 148°43.71'E, Tasmania, 100 km NE of Flinders Island, 1140–1160 m, 13 May 1988; radiograph NMV A; pectoral girdle 801.

**Diagnosis.** Vert. 69, D c. 62, C 8, radials 3, round. Mouth horizontal, terminal, teeth small, simple. Chin pores in a pit, interspace equal to one pore diameter. Gill opening 0.8 eye, ventral end on horizontal with lower margin of eye. P 17+2+4, rudimentary rays absent, upper lobe long, 76 HL. Head 19.3 SL, preanal 33.5, body low, bd 90.4 HL. Colour brown with paler areas. Skin thin, peritoneum black.

**Further description.** Counts: D c. 62, A c. 56, P 23, C 8 (4/4), Vert. 69 (11+58), radials 3 (3+0), pc 5, gr 8, pores 2-6-7-1. Ratios: HL 19.3, its width 10.6 (55) and depth 16.5 (86), bd 17.7 (90.4), bdA 15.9 (82), preD 22.0, preA 33.5, ma 12.9, aAf 22.0, UPL 14.7 (76), LPL 12.8 (67), UPL 87.5, NL —, E 4.7 (24.3), gs 3.8 (19.5), sn 6.9 (35.7), po 9.9 (51.4), io 7.2 (34.3), uj 8.7 (45), lj 8.3 (43), so 3.8 (19.5), pc 3.8–5.5.

Head small, 5.2 in SL, compressed, depth 1.6 its width. Dorsal contour straight, slanted anteriorly to vertical snout. Snout highest point level with upper half of eye, deep, blunt, not projecting, 1.5 eye. Subrostral fold deep, but not covering upper lip entirely. Eye 4.1 in HL, almost touching dorsal contour. Suborbital distance 0.8 eye. Pupil c.  $\frac{1}{2}$  eye. Interorbital flat, 1.5 eye. Nostril small, level with upper margin of pupil, with raised rim. Mouth terminal, horizontal, cleft to below anterior margin of eye. Lower jaw included, chin in ventral view rounded, in lateral view right-angled; lower jaw shallow below oral cleft, honeycomb tissue absent. Lips not wide. Teeth small, slightly prominent. Upper jaw including about 20 rows of up to 8 teeth each, diastema absent; in lower jaw about 24 rows of up to 8 teeth, narrow diastema present. Circumoral pores large, whitish, contrasting with head colour, not in pits,  $n_1$ – $n_2$  widely spaced by a distance about equal to eye, chin pores  $pm_7$  close to eye at about first third of postorbital distance. Chin pores in a distinct pit, oval, interspace about equal to their diameter. Gill opening 0.8 eye, upper end above eye level, lower about on level with lower margin of eye. Opercular flap triangular with rounded ventral margin, covering  $\frac{2}{3}$  length of gill opening, tip above level of eye centre. Gill opening extending ventrally to base of upper pectoral ray.

Upper pectoral lobe about level with mid-eye, not reaching anal fin. Lower pectoral lobe at vertical through anterior third of orbit. Both lobes long; P 17+2+4, rudimentary rays absent. Radials 3 (3+0), round, scapula



**Figure 35.** *Paraliparis gomoni* n.sp. A, holotype, NMV A7124, ripe ♂, 121 mm TL, 110 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 801, cleared and stained right pectoral girdle.

with short helve, coracoid helve long. Pectoral membrane on proximal side of upper lobe attached at about  $\frac{1}{3}$  length, about  $\frac{4}{5}$  of notch and about  $\frac{1}{3}$  of lower lobe.

Body cigar-like, elongated, dorsal contour slightly straighter than ventral contour; shallow, 5.7 in SL, not humpbacked, maximum depth at anal-fin origin. Horizontal midline through lower margin of eye. Vertebral column straight anteriorly, last abdominal vertebra with a short parapophysis without haemal spine. First caudal vertebra with long haemal spine. First dorsal ray shortened, inserted between vertebra 5 and 6, 2 free interneurals present between vertebrae 3–4, 4–5. Costal ridges absent. Epineural ribs only on vertebrae 2–9, epipleural ribs on 2–5, thin, not stout, about 2.5 vertebrae long. Anus at about second third of postorbital length. Urogenital papilla small. Vertical fins overlapping caudal about half. Gelatinous tissue poorly developed. Skin thin, semitransparent, prickles absent. Pyloric caeca unequal, gradually increasing in length.

**Colour.** Head and body brown with paler areas, belly blackish, subrostral fold, lips, mouth, and tongue blackish or dark grey; pectoral fin darker than body. Tooth plates pale. Peritoneum black, stomach, pyloric caeca pale. Branchial cavity dark grey, arches grey.

**Distribution.** Off NE Tasmania, at about 1150 m depth.

**Etymology.** Named after Martin F. Gomon, Senior Curator, Ichthyology, Museum Victoria, Melbourne, Australia, for his contributions to Australian ichthyology.

**Comparative notes.** A member of group IIIb, *P. gomoni* is distinguished by radials 3+0, fenestrae absent, long pectoral-fin lobes, pyloric caeca not only unequal, but progressively increasing in length; colour brown, shallow body lacking humpback, epineural ribs on vertebrae 2–9, epipleural ribs on 2–5, and haemal spine absent on vertebra 11. *Paraliparis gomoni* is most similar to *P. infeliciter* and *Paraliparis* sp.

1; it differs from the former in the absence of pectoral girdle foramina (v. 1), shallower body with a terminal mouth (v. subterminal), lower jaw included (v. subterminal), chin right-angled (v. rounded), Vert. 69 (v. 66), and other characters. It differs from the latter in fenestra (0 v. 3), head depth 86 (v. 77.5), body depth 90.4 (v. 116), pectoral rays 23 (v. 19–21) and other characters.

#### *Paraliparis hobarti* n.sp.

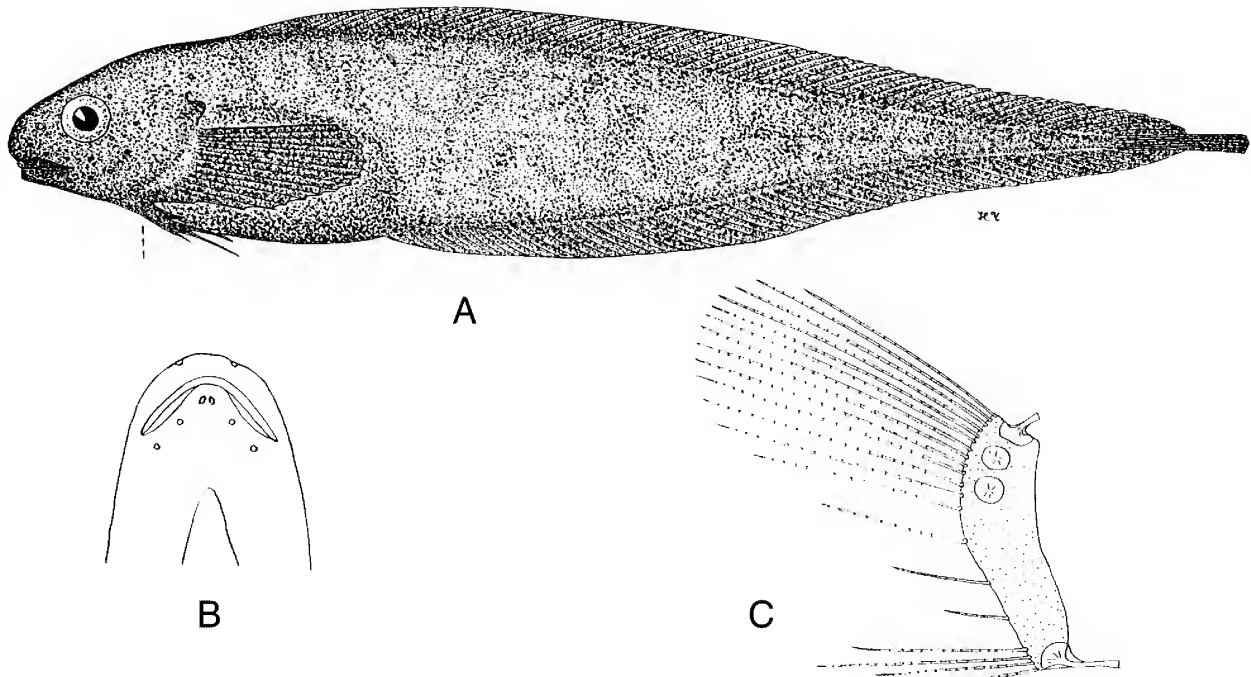
Fig. 36

**Material examined.** HOLOTYPE CSIRO H3170-01, ♀, 140 mm TL, 124 mm SL. Continental slope of Tasmania, no other data; radiograph 681 C; pectoral girdle 792.

**Diagnosis.** Vert. 66, D 60, C 8, radials 2, round. Mouth almost terminal, teeth simple, small. Subrostral fold absent. Chin pores even with chin surface, slit-like. Eye large, 26% HL, snout short. Ventral end of gill opening and uppermost pectoral ray horizontal with lower margin of pupil. Last preoperculo-mandibular pore very close to eye. Pectoral fin long, 83% HL; P 20 (14+2+4), rudimentary notch rays absent. Body deepest at anal-fin origin, bdA 102% HL. Head 18.5% SL, ma long, 14.5%, preanal length 35.5%. Colour light brown, skin semitransparent, peritoneum black.

**Further description.** Counts: D 60, A 54, P 20, C 8 (4/4), Vert. 66 (11+55), radials 2+0+0, gr 8, pc 6, pores 2-6-7-1. Ratios: HL 18.5, its width 10.8 (58), and depth 16.1 (87), bd 19.0 (102), bdA 19.0 (102), preD 21.7, preA 35.5, ma 14.5, aAf 21.8, UPL 15.3 (83), LPL 12.1 (65% HL, 79% UPL), NL 3.2 (21% UPL), E 4.8 (26.0), gs 4.0 (21.7), sn 5.7 (30.8), po 8.4 (45), io 6.9 (37.0), so 2.5 (13.9), uj 8.9 (48), lj 8.1 (43), pc 2.4–4.8.

Head small, 5.4 in SL, deep at occiput, sloping anteriorly to rounded snout. Head depth 1.5 its width. Eye large, not close to dorsal contour of head, suborbital short,  $\frac{1}{2}$  eye.



**Figure 36.** *Paraliparis hobarti* n.sp. A, holotype, CSIRO H3170-01, ♀, 140 mm TL, 124 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 792, cleared and stained right pectoral girdle.

Pupil about half of eye diameter. Interorbital width 1.3 eye, postorbital length short. Snout deeply rounded, short, 1.1 eye, not gelatinous, slightly projecting above upper jaw, subrostral fold absent. Upper lip not wide. Nostril pore-like, level with lower margin of pupil. Mouth almost terminal, horizontal, cleft reaching to below anterior margin of pupil. Chin margin deep, almost right angled but with rounded tip, gelatinous. Lower jaw subterminal, almost equal to upper. Teeth simple, very small, not prominent, in 21–22 rows of up to 9 teeth anteriorly. Diastemae narrow, almost absent. Lower jaw tapering anteriorly, chin edge rounded. Circumoral pores with slightly thickened rims. Chin pores slit-like, interspace (pigmented) less than their diameter, level with chin surface; no skin fold anteriorly. Preoperculo-mandibular pore series unusually close to infraorbital pore series on cheek:  $pm_7$  close to eye, distant from it by  $\frac{1}{3}$  of postorbital space (usual state in *Paraliparis* is  $\frac{1}{2}$ ). Gill opening small, 0.8 eye, dorsal end level with upper margin of eye, ventral end level with lower margin of pupil. Gill opening not vertical, dorsal end anterior to ventral end. Opercular flap triangular, tip rounded, covering  $\frac{2}{3}$  of gill opening, level with upper margin of eye.

Dorsal pectoral ray on horizontal with lower margin of pupil, ventralmost ray on vertical just behind posterior margin of eye. P 20 (14+2+4). Skin on proximal surface of pectoral fin attached to body at bases of upper lobe rays, about  $\frac{3}{4}$  of notch ray length, and at about  $\frac{1}{3}$  of lower lobe length. Pectoral upper lobe not quite reaching anal-fin origin, comparatively long. Rudimentary rays absent. Radials 2+0+0, round; fenestrae absent. Coracoid with long thin helve.

Body elliptic, not deep, 5.3 in SL, deepest at anal-fin origin, dorsal contour broadly rounded anteriorly and posteriorly from this point. Dorsal and ventral contours

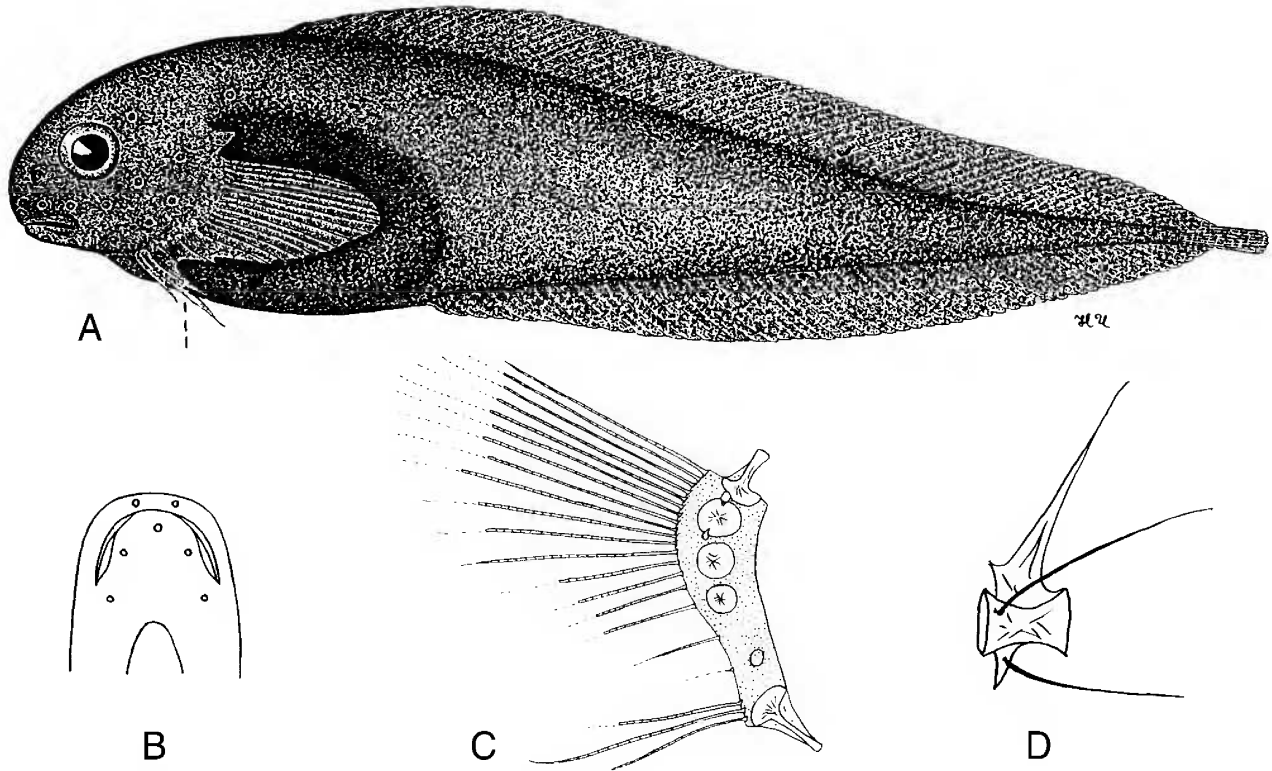
similar. Horizontal midline touches lower margin of pupil. First dorsal ray interneural between neural spines 5 and 6, 1 free interneural between neural spines 4 and 5. Anterior dorsal rays embedded in gelatinous tissue. Posteriormost two or more abdominal parapophyses joined to form short haemal spines. Costal ridges weakly developed. Epineural ribs on vertebrae 2–14, epipleural ribs on 10–11, not long or stout, not more than 2.5 and 2 vertebrae long respectively. Anus below about one-third of postorbital space, distance from mandible to anus long. Vertical fins overlapping caudal fin about half. Skin quite thin, semitransparent. Gelatinous tissue moderately developed. Very small urinary papilla present. Pyloric caeca thick, ends rounded. Ovarian eggs up to 2.5 mm.

**Colour.** Head and body brown, not uniform but with whitish areas from musculature barely visible through semitransparent skin; ventral surface of belly, lips, chin and pectoral fins darker, uniformly blackish-brown. Mouth grey, tongue slightly lighter, also grey. Branchial cavity and gill arches dark grey. Pores, especially on lower jaw, contrasting whitish. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** Continental slope of Tasmania.

**Etymology.** Named after the capital of Tasmania—Hobart.

**Comparative notes.** In group IIIa, distinguished by having only two radials (unnotched), brown colour with whitish areas, absence of a subrostral fold, the preoperculo-mandibular sensory pore series unusually close to the infraorbital series on the cheek, short snout and postorbital head length, long upper pectoral-fin lobe, and other characters.



**Figure 37.** *Paraliparis impariporus* n.sp. A, holotype, CSIRO H3168-01, ♀, 173 mm TL, 162 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 734, cleared and stained right pectoral girdle. D, seventh vertebra.

*Paraliparis impariporus* n.sp.

Fig. 37

**Material examined.** HOLOTYPE CSIRO H3168-01, ♀, 173 mm TL, 162 mm SL. FRV *Soela*, stn. So 2/89/70, 41°51.97'S 144°27.16'E, W coast of Tasmania, W of Trial Harbour, 1040–1050 m, 14 Mar. 1989; radiograph 682F; pectoral girdle 734.

**Diagnosis.** Vert. 70, D 64, P 20–21 (15–16+2+3), C 9, radials 3 (3+1?, see below), round. Mouth subterminal. Teeth large, blunt. Chin pore single, unpaired. Gill opening small, entirely above P base, reaching ventrally to level of eye centre. HL 19.7% SL, about equal to its depth, preanal long, 40%. Body deep, 132% HL, bdA 111%. Colour solid black. Orobranchial cavity and peritoneum black, tongue densely dotted.

**Further description.** Counts: D 64, A 56, P 20–21, C 9 (5/4), Vert. 70 (11+59), radials 3 (3+1?, see below), pc 4, pores 2-6-7-1. Ratios: HL 19.7, its width c. 10.5 (53.5), and depth 15.5 (103), bd c. 20 (132), bdA c. 17 (111), preD 26.8, preA c. 40, ma 14.8, aAf c. 23.4, UPL 14.0 (66), LPL 9.6 (69% UPL), NL 1.7 (13% UPL), E 4.1 (25.8), gs 4.3 (25.6), sn 5.3 (35), io 5.7 (37), po 7.9 (53), uj 7.1 (47), pc 6–7.

Head small, about  $\frac{1}{5}$  SL, deep and compressed, depth and length about equal, width more than half HL, 1.9 width. Dorsal contour of head rounded; snout high, slightly protruding. Interorbital space gently curved, broad, 1.4 eye diameter. Eye moderately large, not touching the upper contour of head; pupil very large, about  $\frac{2}{3}$  eye diameter. Horizontal midline passing through eye centre. Nostril level with lower margin of eye, its rim slightly raised. Mouth

subterminal, lower jaw almost equal to upper jaw. Maxilla reaching slightly behind vertical through mid-eye, oral cleft almost reaching centre of eye. Teeth quite large, stout, blunt canines, closely set in about 30–35 oblique rows of 6–8 teeth each anteriorly, forming moderately wide band in each jaw; narrow diastema present between teeth of each side in upper and lower jaws. Subrostral fold deep, almost entirely covering upper lip anteriorly. Lower jaw partly skinned, honeycomb tissue present on chin; jaw below end of mouth cleft deep. Circumoral pores not large; round, contoured. Chin pore single, unpaired, round, similar in size to other mandibular pores. Free neuromasts on head and body apparently absent. Gill opening vertical, small, about equal to eye, above P fin base, relatively high on side of head, reaching ventrally to level of mid-pupil and in front of first pectoral ray. Opercular lobe small but distinct, triangular, pointed; its tip level with upper margin of eye. Gill rakers 7.

Uppermost pectoral-fin ray about level with middle of pupil. Upper pectoral lobe not nearly reaching anal-fin origin. P 20–21: (16+2+3) (L), (15+2+3) (R). Pectoral-fin notch distinct, moderately deep, of 2–3 more widely spaced rays; rudimentary rays absent. Lower lobe short, of 3 rays, the longest about  $\frac{3}{4}$  upper lobe length. Pectoral radials round, 3 (3+0), but probably 4 (3+1); at normal location of lowest radial only an empty pit present. Two rudimentary fenestrae present at upper and lower margins of uppermost radial. Helve of scapula well developed; coracoid with elongated helve with two lateral ribs.

Body tapering gradually towards tail, very deep, greatest depth at about the level of posterior part of pectoral fin, much greater than HL. Trunk depth similar, predorsal long. Anterior dorsal rays short, embedded in gelatinous tissue. Interneurals of first and second dorsal rays between 5th and

6th spines; no ray between 6 and 7th neural spines. One free rayless interneural discernible before anteriormost ray. Parapophyses of last (11th) abdominal vertebra grown together, forming rather short haemal spine. Epineural ribs at 2nd–10th vertebrae, epipleural ribs at 3rd–17th; all thin, 2.5–3 vertebrae long. Caudal fin of 9 (5/4) rays, procurrent rays absent. Degree of overlap with vertical fins unknown owing to damage. Anus below  $\frac{2}{3}$  of postorbital space, mandible to anus long. Skin thick, prickles absent; subcutaneous gelatinous layer moderately developed. Pyloric caeca digitate, of similar length.

**Colour.** Body colour solid black, oral cavity densely black, tongue densely dotted, tooth plates pale, skin fold behind tooth plates inside mouth black. Inner surface of subrostral fold densely dotted, almost black. Lower lip dark grey. Gill arches light grey. Branchial cavity and peritoneum black. Stomach and pyloric caeca pale.

**Distribution and biology.** West coast of Tasmania, Australia, at a depth of 1040–1050 m. Collected by a demersal trawl, *P. impariporus* is probably benthic or benthopelagic. The holotype is a female, 173 mm TL, that appears to have spawned shortly before capture (early March): rather than being filled with eggs to form a solid mass, the cavity of the ovary is hollow. The largest eggs are 1.7 mm in diameter, and unripe.

**Etymology.** *Impariporus* from the Latin *impar*—unequal and *porus*—pore, to note the single (rather than paired) terminal mandibular pore.

**Comparative notes.** *Paraliparis impariporus* belongs to group IIIa. It differs in having a single chin pore, a very deep and compressed head and body with long predorsal and preanal lengths, gill opening high on the side and

reaching ventrally to the eye centre, the subrostral fold inside densely dotted, and other characters. It is similar to *P. monoporus* Andriashev & Neelov (1979) from the Antarctic in having a single, unpaired symphyseal mandibular pore, but distinctly differs in being entirely black including the orobranchial cavity (v. a uniformly pale body and orobranchial cavity, orange-red in life), longer gill opening (4.3% SL v. 2.1–2.2%), and radials 2+1 (v. 3+1). Differences in counts are not great (Vert. 70 v. 72–74, A 56 v. 58–62, P 20–21 v. 22–25).

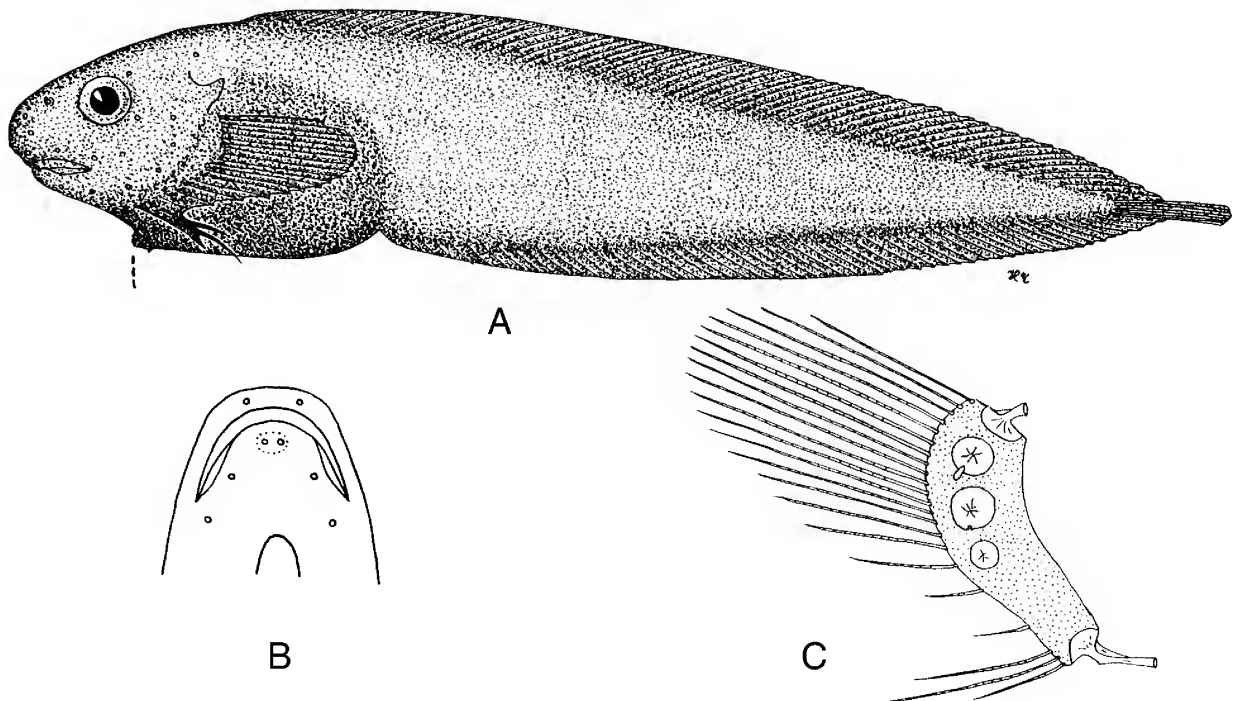
***Paraliparis infeliciter* n.sp.**

Fig. 38

**Material examined.** HOLOTYPE CSIRO H3169-01, ripe ♀, 170 mm TL, 153 mm SL. FRV *Soela*, stn. So 1/88/48, 37°37.9'S 139°00.60'E, South Australia, W of Cape Banks, 1070–1090 m, 30 Jan. 1988; radiograph 682 D; pectoral girdle 798. Specimen from *Hoplostethus atlanticus* stomach.

**Diagnosis.** Vert. 66, D 60, C 8, radials 3+0, uppermost notched. Interneural of first dorsal ray between neural spines 6 and 7. Mouth subterminal, lower jaw subterminal. Teeth simple, small. Chin pores in a pit on lower surface of chin, space between unpigmented, equalling their diameter. Ventral end of gill opening and dorsal pectoral ray level with lower margin of pupil. P 17+2+3, rudimentary notch rays absent. Head 19.1% SL, compressed (width 55% HL), and depressed (depth 72% HL); preanal distance 34%, mandible to anus short, 10.5% SL. Colour blackish-brown, paler laterally; peritoneum black.

**Further description.** Counts: D 60, A 55, P 22, C 8 (4/4), Vert. 66 (11+55), radials 3+0, gr 8, pc 6, pores 2-6-7-1. Ratios: HL 19.1, its width 10.5 (55), and depth 13.7 (72),



**Figure 38.** *Paraliparis infeliciter* n.sp. A, holotype, CSIRO H3169-01, ripe ♀, 170 mm TL, 153 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 798, cleared and stained right pectoral girdle.

bd 20.9 (109), bdA 15.4 (80), preD 23.2, preA 34.0, ma 10.5, aAf 21.6, UPL 11.8 (62), LPL 8.5 (44.5% HL, 72% UPL), NL 2.9 (25% UPL), E 4.7 (24.7), gs 3.3 (17.5), sn 6.5 (34.2), po 8.6 (45.2), io 7.4 (38.7), so 2.9 (15.1), uj 8.5 (45.4), lj 8.0 (42), pc 4.3.

Head small, 5.2 in SL, compressed, low, depth 1.3 its width. Eye not entering dorsal contour of head, suborbital space and pupil  $\frac{3}{4}$  eye. Interorbital space rounded, 1.6 eye. Snout deep, rounded, 1.4 eye, slightly projecting anterior to upper jaw, highest point level with upper margin of pupil. Subrostral fold well developed, deep, not covering upper lip. Nostril level with lower half of eye. Mouth subterminal, horizontal, cleft reaching to below anterior third of eye. Lower jaw subterminal, almost included. Teeth simple, small, in upper jaw in 22–24 rows of up to 9–10 teeth anteriorly. Diastemae of both jaws narrow. Chin in ventral view rounded; skinned, thin honeycomb tissue visible; lower jaw shallow below posterior of oral cleft. Circumoral pores small, chin pores in a small unpigmented pit, rims thickened, interspace equals their diameter; on lower surface of chin. Postorbital head length short. Gill opening small, vertical, ventral end on horizontal with lower half of pupil, dorsal slightly above eye. Opercular flap triangular, covering lower  $\frac{2}{3}$  of gill opening, lower margin rounded, tip level with upper margin of eye.

Uppermost pectoral ray level with lower margin of pupil. P 17+2+3, rudimentary rays absent. Upper lobe short, not reaching anal-fin origin; lower lobe short, lowest ray below posterior margin of eye. Fin membrane missing. Radials 3+0, lowest small. R1 notched with a small ventral fenestra in notch; R2 with a tiny rudimentary ventral notch. Coracoid with unusually strong, long helve.

Body deepest at dorsal-fin origin; body shape unclear owing to damage. Dorsal contour broadly rounded anteriorly, evenly tapering posteriorly. Horizontal midline passes through eye centre. Anterior of dorsal fin possibly damaged; interneural of first dorsal ray apparently between neural spines 6 and 7; 3 free interneurals present anteriorly between neural spines 3–6. Anterior dorsal rays embedded in gelatinous tissue. Parapophyses of abdominal vertebrae distinctly separate. Costal ridges absent. Epineural ribs on vertebrae 2–8, anteriorly not long, not stout, length less than 3 vertebrae; epipleurals not clearly visible on radiograph. Anus below anterior third of postorbital space, mandible-anus length short. Genital papilla absent. Skin thin, translucent, prickles absent. Gelatinous tissue moderately developed. Ovarian eggs to 2.9 mm. Pyloric caeca similar, pointed.

**Colour.** Light blackish-brown, skin on sides of trunk paler, finely dotted; anal region blackish. Subrostral fold brightly black-dotted. Lips slightly paler than head, grey. Oral cavity black-dotted: tongue and palatal skin fold behind upper tooth plates grey, soft palate itself paler. Branchial cavity brown, gill arches grey. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** Off eastern South Australia, 1070–1090 m.

**Etymology.** *Infeliciter* from the Latin “bad luck”; thus named because the specimen was eaten by an orange roughy (*Hoplostethus atlanticus*).

**Comparative notes.** A member of group IIIb, *P. infeliciter* is distinguished by its comparatively light brown colour,

thick layer of honeycomb tissue on the chin, chin pores with an unpigmented interspace, radials 3+0, notched R1 and R2 with one fenestra, coracoid with an unusually stout and long helve, nephrohaemal canal absent, triangular opercular flap, and rounded snout with a short oral cleft. It is most similar to *P. gomoni* and *Paraliparis* sp. 1, but differs from both in having a subterminal lower jaw (*v.* included). See descriptions of both species for specific differences.

### *Paraliparis labiatus* n.sp.

Fig. 39

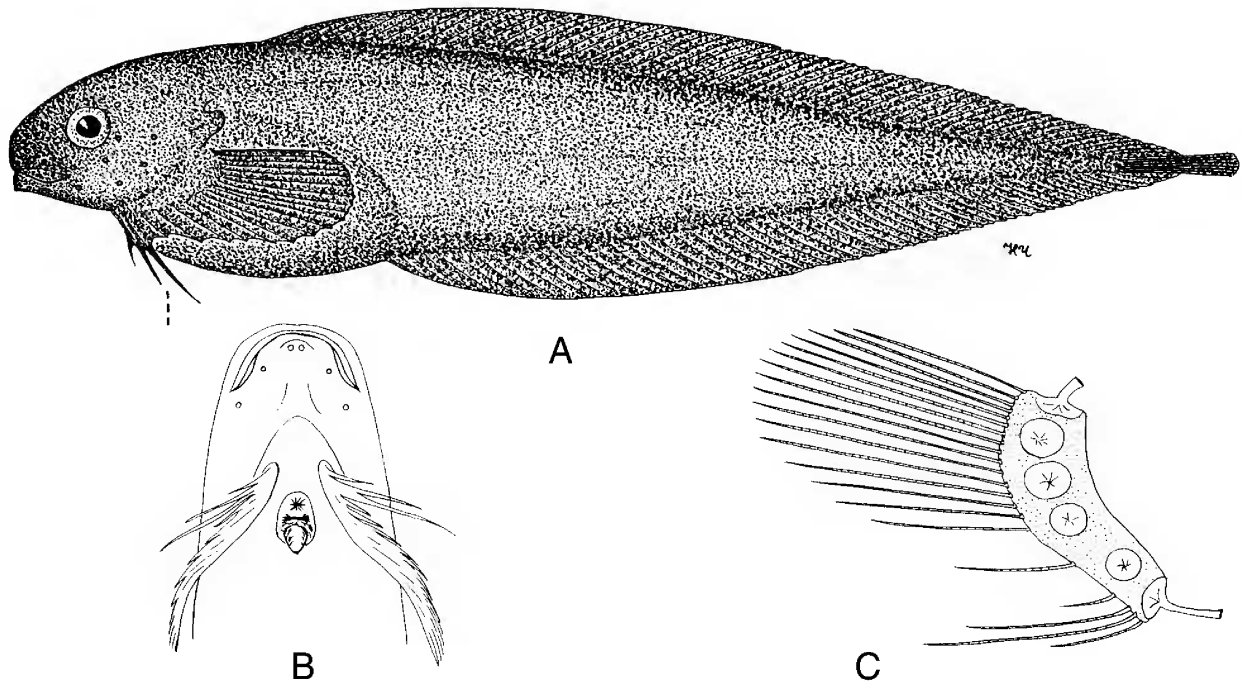
**Material examined.** HOLOTYPE CSIRO H749-02, ♀, 166 mm TL, 150 mm SL. FRV *Soela*, stn. So 3/86/32, 44°45.8'S 144°24.8'E, W coast of Tasmania W of Granville Harbour, 1000–992 m, 16 May 1986; radiograph 682 B; pectoral girdle 790.

**Diagnosis.** Vert. 66, D 59, C 8, radials round. Mouth terminal, teeth small. Lateral profile of chin right-angled; chin with thick gelatinous layer, pores protected by anterior skin fold. Upper lip wide posteriorly, entirely covering lower lip fold. Eye comparatively small, 21% HL, interorbital broad, 44%. Lower end of gill opening and uppermost pectoral ray level with lower margin of eye. P 16+2+3, rudimentary rays absent. HL 19.3% SL, preA 35%. Vertical fins overlapping caudal fin slightly more than half. Females with prominent genital papilla. Colour dark blackish-brown, peritoneum black, tongue grey-dotted.

**Further description.** Counts: D 59, A 53, P 21, Vert. 66 (11+55), C 8 (4/4), radials 4 (3+1), pc 5, gr 7, pores 2-6-7-1. Ratios: HL 19.3, its width 12.7 (66), and depth 15.3 (79), bd 20.7 (107), bdA 20 (103), preD 24.7, preA 34.7, ma 13.7, aAf 22.0, UPL 13.3 (69), LPL 10.7 (55% HL, 80% LPL), NL c. 2.0 (15% UPL), E 4.1 (21.0), sn 6.9 (35.9), gs 4.3 (22.4), io 8.5 (44.1), po 10.0 (52), so 3.2 (16.6), uj 8.3 (43), lj 7.7 (40), pc 6.6.

Head small, 5.2 in SL, its dorsal contour rounded anteriorly; wide, its depth 1.2 its width. Eye small, 4.8 in HL, upper contour clearly below dorsal profile of head, suborbital space about  $\frac{3}{4}$  eye. Pupil half eye diameter. Interorbital space gently curved, broad, 2.1 eye. Snout deep, bluntly rounded, anterior profile vertical, highest point level with lower margin of pupil; not projecting beyond upper lip; its length 1.7 eye. Subrostral fold present, deep anteriorly and covering upper lip almost entirely; shallow posteriorly where upper lip is wide and prominent. Nostril short, tubular, level with lower half of pupil. Mouth horizontal, terminal, cleft reaching to below anterior margin of eye. Lower jaw terminal, almost equal to upper. Upper lip wider laterally than anteriorly, entirely covering lower lip fold. Teeth very small, not prominent, in about 25 oblique rows of up to 9 teeth each anteriorly; lower jaw tooth plates damaged. Diastema of upper jaw narrow, wider than that of lower jaw. Circumoral pores small; chin pores closely set, interspace equal to their diameter; anterior skin fold vertical, high; in lateral view, chin appears right-angled. In ventral view, chin blunt; skin partially missing, a peculiar honeycomb structure of subcutaneous tissue clearly visible. Lower jaw shallow below posterior of mouth cleft. Gill





**Figure 39.** *Paraliparis labiatus* n.sp. A, holotype, CSIRO H749-02, ♀, 166 mm TL, 150 mm SL. B, ventral view of mouth, lower jaw, and genital papilla. C, P 790, cleared and stained right pectoral girdle.

opening small, about equal to eye, vertical, completely above pectoral base; lower end level with lower margin of eye. Opercular flap ear-shaped, tip on horizontal through upper margin of eye.

Uppermost pectoral ray level with lower margin of eye. Pectoral fin 16+2+3, rudimentary notch rays absent. Upper lobe not reaching anal-fin origin, lower lobe short. Lowest ray below posterior margin of eye. Pectoral-fin membrane missing. Pectoral girdle with 4 (3+1) radials; all round, of similar sizes, distance between R3 and R4 short. Fenestrae absent. Scapula and coracoid each with a long helve.

Body elliptic, deep, 4.8 in SL; greatest depth close to anal-fin origin. Upper and lower body profiles similar. Horizontal midline touching lower margin of eye. Anterior half of dorsal-fin rays embedded in gelatinous tissue. Interneural of the first (rudimentary) dorsal ray between neural spines 5 and 6; one free interneural present anteriorly. Caudal-fin rays 4/4. Short haemal spines present on vertebrae 9–11. Epineural ribs present on vertebrae 2–18, thin and short, length not exceeding 2 vertebrae. Epipleural ribs not visible in radiograph; if present, very slim. Vertical fins overlapping caudal fin slightly more than half. Anus below posterior third of postorbital space. Anal-genital area unusual: prominently swollen, a short, thick cone-shaped genital papilla present behind oviduct opening, its length about equal to half of eye. Skin on body entirely missing; skin on head thin, translucent. Subcutaneous gelatinous tissue well developed. Pyloric caeca similar. Ovaries full of eggs at different stages of maturity, not ripe, largest about 1 mm in diameter.

**Colour.** Remains of skin on head dark blackish-brown. Inner surface of subrostral fold bright black-dotted, similar to head colour; lips and chin margin lighter, grey. Mouth dark grey, tongue lighter, grey-dotted, tooth plates pale.

Branchial cavity dark brown, gill arches grey, black-dotted. Peritoneum black, anal area and genital papilla black. Pyloric caeca pale.

**Distribution.** West coast of Tasmania at 1000–992 m.

**Etymology.** *Labiatus* from the Latin, having large lips.

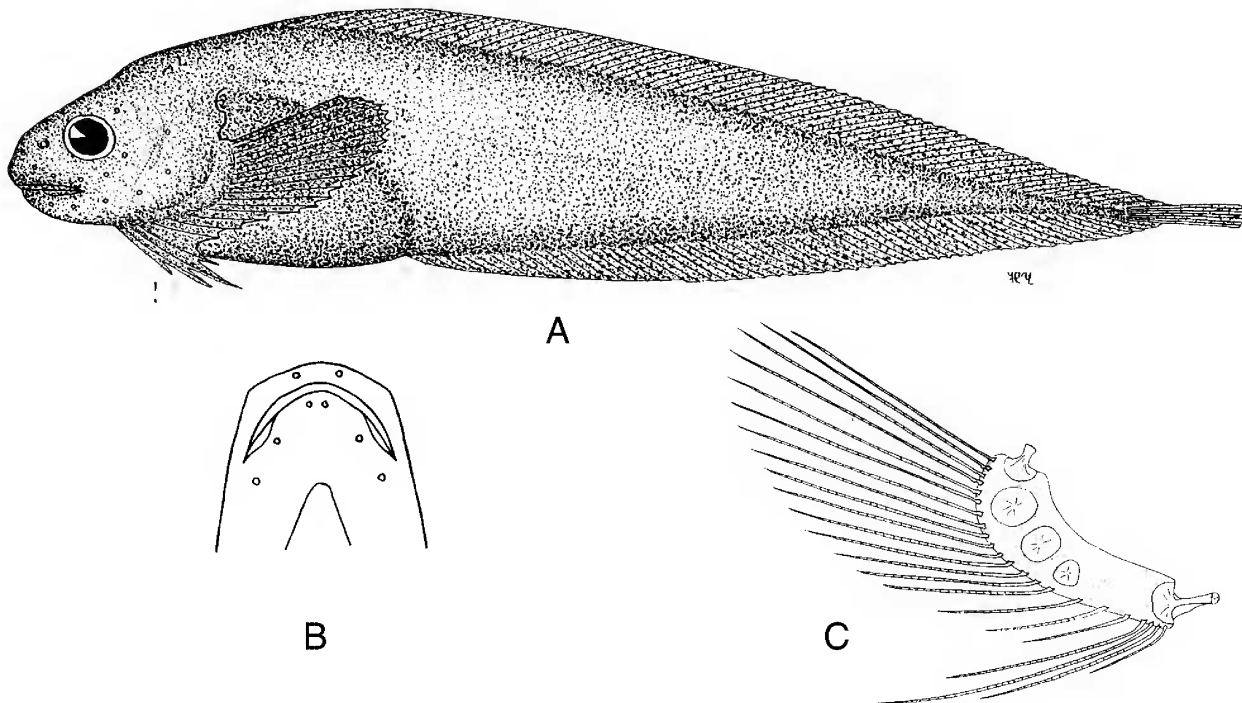
**Comparative notes.** *Paraliparis labiatus* is in group IIIc. It is distinguished by its chin shape and structure (right-angled in lateral profile with honeycomb tissue), upper lip covered only anteriorly by the posteriorly wider subrostral fold, broad head, small eye, broad interorbital, unusual female genital papilla, pectoral girdle structure with 4 radials of similar size (distance between radials 3 and 4 short) and absence of fenestrae. It is most similar to *P. brunneus* but differs (in addition to the above characters) in the absence of fenestra in the pectoral girdle (v. 3 present), the shape of the opercular flap, and smaller eye (21% SL v. 24%). It is also similar to *P. anthracinus*, but differs by the gill opening reaching ventrally to the uppermost pectoral-fin ray (v. to the second), subrostral fold (v. absent), and blackish-brown colour (v. coal black).

#### *Paraliparis lasti* n.sp.

Fig. 40

**Material examined.** HOLOTYPE CSIRO T982-02, ♂, 205 mm TL, 185 mm SL. FV *Petuna Endeavour*, stn. PE 4/10, 33°45.5'S 129°37.5'E, South Australia, Great Australian Bight, 1152–1000 m, 5 June 1983; radiograph 684 C; pectoral girdle 779.

**Diagnosis.** Vert. 70, D 63, C 8, P 22 (15+3+4), rudimentary rays absent. Radials 3, round. Mouth



**Figure 40.** *Paraliparis lasti* n.sp. A, holotype, CSIRO T982-02, ♂, 205 mm TL, 185 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 779, cleared and stained right pectoral girdle.

horizontal, subterminal, lower jaw included; teeth large, stout; chin pores paired, small, not in pits. Uppermost pectoral ray horizontal with eye centre. HL 19.7% SL, preA 37% SL. Mandible to anus short, 11.4% SL. Skin semitransparent, reddish-brown, peritoneum brownish-black.

**Further description.** Counts: D 63 (1 rudimentary+62), A 57, P 22, C 8 (4/4), Vert. 70 (12+58), radials 3 (3+0), pc 7, gr 9, pores 2-6-7-1. Ratios: HL 19.7, its width 11.4 (57.5), and depth 14.9 (75), bd 21.1 (107), bdA 17.8 (90), preD 26.0, preA 36.8, ma 11.4, aAf 23.1, UPL 14.9 (75), LPL 13.5 (90% UPL), NL 4.1 (27% UPL), sn 6.7 (33.1), E 4.6 (23.6), gs 4.3 (22.0), io 7.3 (37.0), po 12.2 (49.3), so 2.8 (14.2), uj 10.3 (52), lj 8.6 (43.8), pc 5.4.

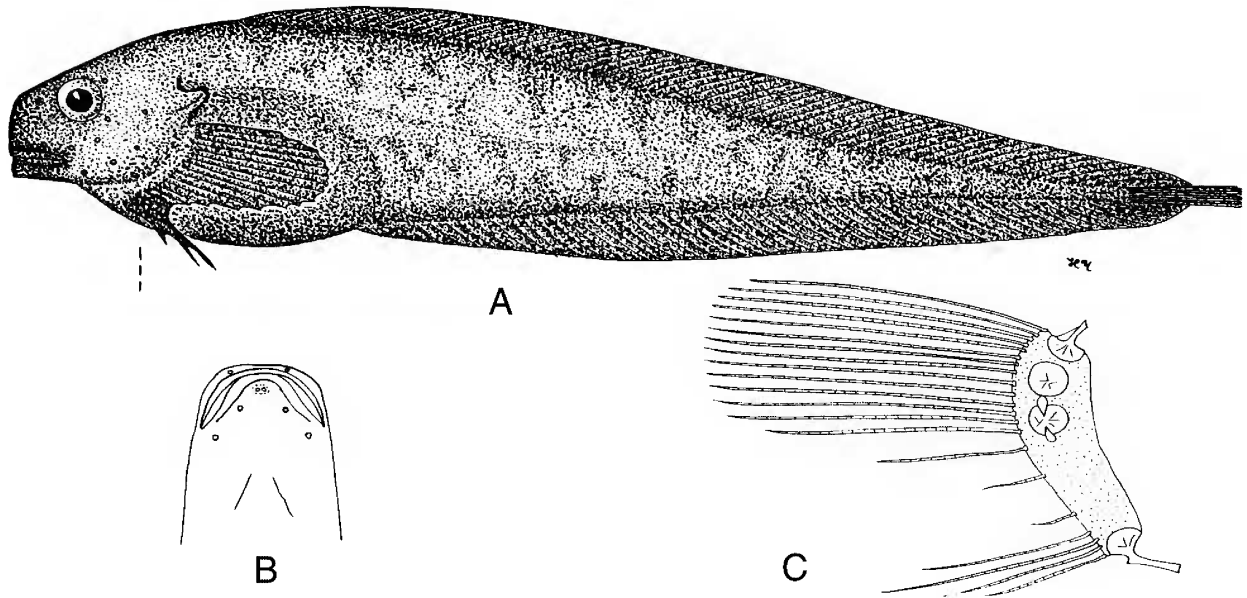
Head not large, 5 in SL, deep at occiput; dorsal contour significantly sloping anteroventrally. Head quite compressed, its width more than half its length, its depth 1.3 its width. Snout quite large, bluntly rounded, 1.4 eye, projecting above upper jaw, its highest point horizontal with eye centre. Subrostral skin fold developed, covering upper half of upper lip. Eye 4.2 in HL, not entering dorsal contour of head. Pupil  $\frac{3}{4}$  eye diameter. Interorbital space 1.6 eye. Suborbital distance almost  $\frac{3}{5}$  eye. Nostril large, pore-like, level with lower half of pupil. Mouth horizontal, subterminal, its cleft reaching to below centre of eye. Lower jaw included; in ventral view, if upper lip pushed aside upper tooth plates visible. Upper jaw long, chin tapering in ventral view, symphysis slanted but not right-angled in lateral view, lips not wide. Lower jaw below angle of mouth cleft quite deep. Teeth simple, large, stout, slightly blunt, in 23–25 quite regular oblique rows, 8–10 teeth per row anteriorly. Diastema of upper jaw wider than at lower jaw. Circumoral pores small, not in pits. Chin pores spaced at 1.5 times their diameter, interspace pigmented, not in a pit and without skin fold

anteriorly. Gill opening length 0.9 eye diameter, entirely above pectoral base, vertical, dorsal end clearly above level of eye upper margin, lower end horizontal with eye centre. Opercular flap small, triangular, with notched upper rim, covering lower half of gill opening, tip level with upper margin of eye.

Uppermost pectoral-fin ray level with eye centre and below opercular tip, lowermost ray inserted below posterior margin of eye. Upper and lower pectoral lobes long; upper lobe not reaching anal-fin origin, 22 (15+3+4). Notch ray length about  $\frac{1}{4}$  UPL, lower lobe length not quite equal to UPL. Skin on proximal surface of upper lobe attached at ray bases, notch and lower lobe unknown. Basal cartilaginous lamina of pectoral girdle with 3 (3+0) round radials in upper half of basal lamina, R3 smallest. Fenestrae absent. Helve of scapula stout. Coracoid with long helve with ventral lateral rib.

Body deep, humpbacked, greatest depth at dorsal-fin origin, depth at A origin slightly less. Predorsal length long. Dorsal contour much more curved than ventral contour. Horizontal midline of body goes through eye centre. First dorsal-fin ray rudimentary, its interneural between neural spines 5 and 6; one free interneural between neural spines 4 and 5. Haemal spine of the last (12th) abdominal vertebra short. Epineural ribs on vertebrae 2–15, epipleurals on 3–15, thin and not long, lengths not more than 2–2.5 vertebrae. Ribs producing lateral keel-like body ridges above first half of pectoral fins, but not prominent. Anus below the middle of postorbital space, mandible-anus distance short. Vertical fins overlapping caudal at  $\frac{1}{3}$  of its length. Skin thin, semitransparent. Subcutaneous gelatinous tissue slightly developed. Pyloric caeca similar in size.

**Colour.** Uniform bright reddish-brown, anteriorly slightly lighter. Snout and chin brown, lips paler, greyish-brown.



**Figure 41.** *Paraliparis obtusirostris* n.sp. A, holotype, NMV A7123, ripe ♀, TL unknown, 137 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 800, cleared and stained right pectoral girdle.

Mouth light grey, tongue grey-dotted. Branchial cavity blackish, gill arches pale. Anal region blackish. Peritoneum brownish-black, stomach and pyloric caeca pale.

**Distribution.** Great Australian Bight, depth 1152–1000 m.

**Etymology.** The new species is named in honour of Peter R. Last of the CSIRO Division of Marine Research, Hobart, Tasmania, whose studies of Australian fishes have added fundamentally to knowledge of the deep-sea fauna of that region.

**Comparative notes.** *Paraliparis lasti* is in group IIIa, and is distinguished by its thin, semitransparent, reddish-brown skin, dorsally-located gill opening (lower end level with eye centre), long predorsal length, short mandible-anus distance, and long pectoral-fin lobes. It is most similar to *P. piceus*, see that species for comparison. It is also similar to *P. dewitti* n.sp. but differs in having 3 (3+0) (v. 4 (3+1) radials), teeth large and stout (v. small), symphyseal mandibular pores not embedded (v. in an oval depression), chin angled (v. bluntly rounded), skin bright, reddish-brown (v. nut-brown), pyloric caeca pale (v. grey), snout 1.4 eye (v. 1.8), interorbital width 1.6 eye (v. 2), and vertebrae 70 (v. 65).

***Paraliparis obtusirostris* n.sp.**

Fig. 41

**Material examined.** HOLOTYPE NMV A7123, ripe ♀, TL unknown, 137 mm SL. FRV *Soela*, stn. So 3/88/10, 38°57.09'S 148°41.95'E, off Tasmania, 100 km NE of Flinders I., 1270–1290 m, 13 May 1988; radiograph NMV B; pectoral girdle 800.

**Diagnosis.** Vert. 66, D 62, C 9, radials 2, lowest notched. First dorsal ray interneural between neural spines 4–5. Mouth terminal, lower jaw subterminal. Teeth simple, small. Chin pores in small unpigmented pit, almost touching. Lower end of gill opening and uppermost pectoral ray level with lower half of pupil. P 14+3+4 to 14+2+3, rudimentary rays absent. Head 18.6% SL, preanal 33%. Body light brown with variable pattern, peritoneum black.

**Further description.** Counts: D 62, A 55, P 19–21, C9 (1+4/4), Vert. 66 (11+55), radials 2+0+0, fenestrae 2, pc unknown, gr 8, pores 2-6-7-1. Ratios: HL 18.6, its width 11.3 (61), and depth 16.4 (88), bd 20.4 (110), bdA 17.2 (92), preD 22.8, preA 33.3, ma 12.3, aAf 21.5, UPL 12.8 (69), LPL 9.5 (50.1% HL, 74% UPL), NL 1.8 (14.2% UPL), E 4.7 (25.5), gs 4.2 (22.7), sn 7.3 (39.2), po 9.9 (53), io 6.6 (35.6), so 3.6 (19.6), uj 8.2 (44), lj 7.9 (42.4).

Head small, 5.3 in SL, deep at occiput, dorsal contour sloping straight anteriorly to blunt snout. Head not much compressed, its width 0.6 its length, depth 1.5 width. Eye large, 3.9 in HL, almost entering dorsal contour of head, suborbital almost equal to eye. Pupil about ½ eye. Interorbital 1.4 eye, suborbital distance about 0.8 eye. Snout deep, blunt, 1.5 eye, not projecting anterior to upper jaw, its highest point horizontal with upper margin of pupil. Subrostral fold not deep, not entirely covering upper lip. Upper lip not wide. Nostril almost on level with eye centre. Mouth terminal, horizontal, its cleft reaching to below anterior half of pupil. Lower jaw subterminal, almost equal to upper. Teeth simple, small, barely projecting; in upper jaw in 21–22 rows of 9 teeth each anteriorly. Diastemae absent. Chin rounded in ventral view, tip right-angled in lateral view, shallow below posterior of mouth cleft. Circumoral pores not in pits, contoured. Nasal pores widely spaced at about ⅓ eye diameter. Chin pores in a shallow unpigmented depression almost touching. Gill opening not

short, 0.9 eye, lower end level with lower half of pupil. Opercular flap triangular, covering  $\frac{2}{3}$  of gill opening, its tip rounded, level with upper margin of eye.

Uppermost pectoral ray on horizontal with lower half of pupil. Base of lowermost ray below first third of postorbital space. Pectoral rays not reaching anal-fin origin. Pectoral fin 14+2+3 (L), 14+3+4 (R), rudimentary rays absent. Skin of pectoral-fin proximal side attached at about  $\frac{1}{4}$  upper lobe length,  $\frac{3}{4}$  notch length,  $\frac{1}{3}$  lower lobe length. Radials 2+0+0, R1 round, R2 notched above and below, two fenestrae present. Coracoid with long thin helve.

Body humpbacked, deepest at dorsal-fin origin, 4.9 in SL. Horizontal midline passes through eye centre. Preanal length 33% SL. First dorsal ray interneural between neural spines 4 and 5, first and second dorsal rays shortened, one free interneural present anteriorly between neural spines 3–4. Anterior dorsal rays embedded in gelatinous tissue. Parapophyses of abdominal vertebrae unjoined. Costal ridges absent. Epineural ribs on vertebrae 2–16, epipleural ribs on 3–18, anterior ribs not long, not stout, shorter than 2.5 vertebrae. Anus below posterior  $\frac{2}{3}$  of postorbital space. Caudal fin with one dorsal procurrent ray. Skin quite thin, slightly transparent, prickles absent. Gelatinous tissue moderately developed. Genital papilla absent. Eggs in ovaries of different size, the largest 2.4 mm. Pyloric caeca not studied.

**Colour.** Uniformly light brown, with variable markings, pectoral fins and anal area blackish. Subrostral fold and upper lip blackish, slightly darker than head. Mouth grey, tongue pale, black-dotted, tooth plates pale. Branchial cavity black, gill arches grey. Peritoneum black. Pyloric caeca and stomach pale.

**Distribution.** Coast of NE Tasmania, 1270–1290 m.

**Etymology.** *Obtusirostris* from the Latin, meaning “with blunt snout.”

**Comparative notes.** *Paraliparis obtusirostris* is in group IIIb, and is distinguished by its brown colour, blunt deep snout, presence of a caudal procurrent ray, two shortened anterior dorsal-fin rays, and unjoined parapophyses of all abdominal vertebrae. Most similar to *Paraliparis* sp. 2, it differs in having 2 pectoral girdle fenestrae (v. none), a well-developed subrostral fold (v. absent), absence of costal keels (v. present), and light brown colour (v. black).

***Paraliparis piceus* n.sp.**

Fig. 42

**Material examined.** HOLOTYPE CSIRO H805-04, ripe ♂, 167 mm TL, 149 mm SL. FRV *Soela*, stn. So 3/86/41, 41°51.25'S 144°23.1'E, W coast of Tasmania, W of Trial Harbour, 1384–1416 m, 18 May 1986; radiograph 682 C; pectoral girdle 796.

**Diagnosis.** Vert. 66, D 59, C 8, 3 radials, upper dorsally notched. Mouth terminal, teeth simple, small; chin pores not in a pit or other depression, interspace equals their diameter. Gill opening ventral end and dorsal pectoral ray on horizontal through eye centre. Opercular flap dorsally rounded, tip of operculum dorsally directed. P 16+3+3, rudimentary rays absent. HL 18% SL, preanal length 34%.

Body and head dark blackish-brown, mouth and tongue grey, peritoneum black.

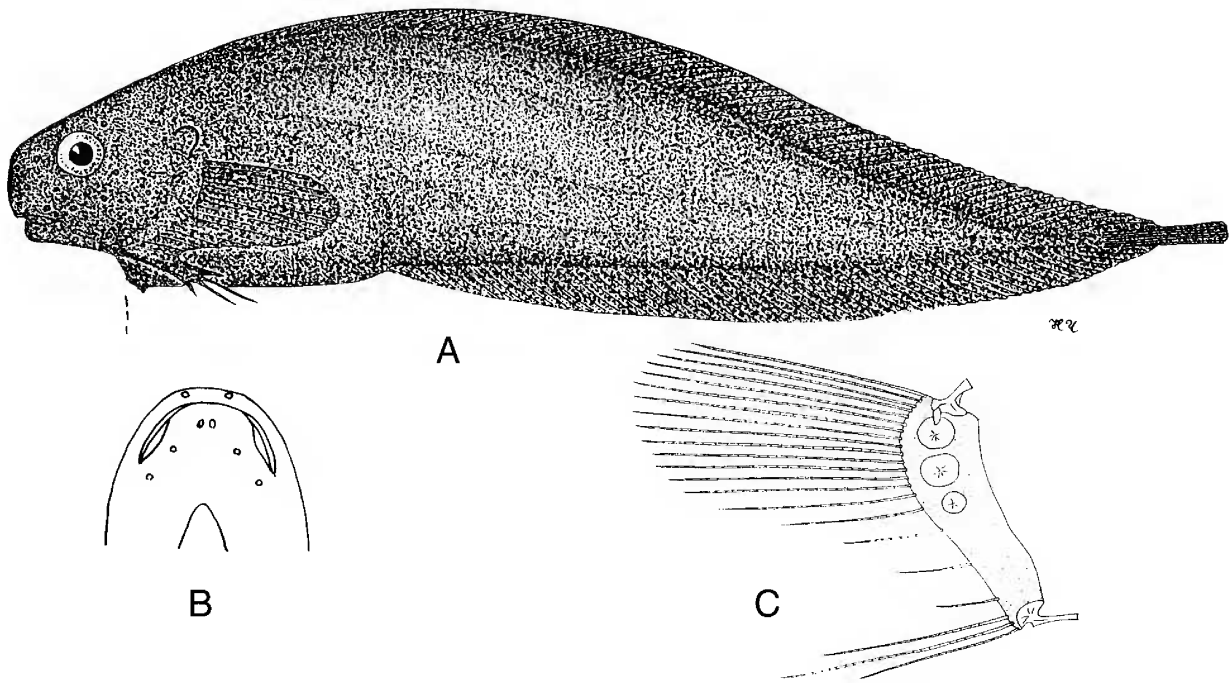
**Further description.** Counts: D 59, A 55, P 22, C 8 (4/4), Vert. 66 (11+55), radials 3+0, one fenestra, gr 7, pc 5, pores 2-6-7-1. Ratios: HL 18.1, its width 11.8 (65), and depth 16.8 (93), bd 21.5 (119), bdA 19.7 (108), preD 21.1, preA 34.2, ma 12.6, aAf 21.8, UPL 14.1 (78), LPL 12.1 (67% HL, 86% UPL), NL 3.4 (24% UPL), E 4.3 (23.7), gs 3.4 (18.5), sn 6.0 (33), io 6.7 (37), po 9.5 (52.6), so 3.4 (18.5), uj 8.1 (44.4), lj 8.1 (44.4), pc 6.7.

Head small, 5.5 in HL, slightly compressed, depth 1.4 its width. Dorsal contour slopes significantly from deep occiput to vertical snout. Eye large, 4.2 in head, close to dorsal contour of head; suborbital space about 0.8 eye. Pupil about half eye. Interorbital space slightly rounded, 1.6 eye. Snout 1.4 times eye, deep, bluntly rounded, not projecting anteriorly beyond jaw, its highest point horizontal with eye centre. Subrostral fold present, much deeper anteriorly than laterally, not covering upper lip posteriorly. Lips not wide. Nostril pore-like, level with lower margin of pupil. Mouth terminal, horizontal, cleft reaching to below anterior margin of eye. Lower jaw subterminal, slightly shorter than upper. Teeth simple, small, slightly prominent, blunt, in 23–24 rows of up to 7–8 teeth anteriorly. Diastema of upper jaw narrow, but wider than that in lower jaw. Chin right-angled in lateral view, symphyseal knob large, vertical, clearly seen on radiograph. Lower jaw below angle of mouth cleft shallow. Circumoral pores small. Chin pores closely set, interspace equal to their diameter, not in a pit or other depression; interspace pigmented. Gill opening short, 0.8 eye diameter, its ventral end level with eye centre. Opercular flap rounded dorsally; not vertical (dorsal end in front of vertical of ventral end), tip of operculum directed dorsally, about level with upper margin of eye.

Uppermost pectoral ray on horizontal through eye centre. Upper pectoral lobe long. Lowermost ray insertion below first quarter of postorbital space. P 16+3+3, rudimentary rays absent. Skin on proximal surface of upper pectoral-fin lobe attached at base, in notch attached almost at ray tips, in lower lobe at about  $\frac{1}{4}$  lobe length. Radials 3+0, R1 with a small dorsal notch, small fenestra present. Coracoid with long thin helve.

Body leaf-like, deep and compressed, maximum depth at anal-fin origin, 4.7 in SL. Dorsal contour very rounded, ventral contour almost straight. Horizontal midline through lower half of eye. First dorsal ray interneural between neural spines 5 and 6; one free interneural present anteriorly. Parapophyses of anterior abdominal vertebrae separate, last three joined. Nephrohaemal canal present on vertebrae 9–11, short. Epineural ribs on vertebrae 3–13, thin and short, lengths about equal to two vertebrae; epipleural ribs not clearly visible on radiograph. Costal ridge absent. Anus below anterior third of postorbital space, small urogenital papilla present. Vertical fins overlap anterior half of caudal fin. Skin without prickles, opaque. Gelatinous tissue moderately developed. Pyloric caeca of similar lengths.

**Colour.** Body, head, lips, inner surface of subrostral fold, and chin uniformly dark blackish-brown. Mouth dark grey, tongue grey, tooth plates pale. Pores pale, clearly contrasting. Branchial cavity dark grey, gill arches lighter, also grey. Urogenital papilla black. Peritoneum black, stomach and pyloric caeca pale.



**Figure 42.** *Paraliparis piceus* n.sp. A, holotype, CSIRO H805-04, ripe ♂, 167 mm TL, 149 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 796, cleared and stained right pectoral girdle.

**Distribution.** West coast of Tasmania, 1384–1416 m.

**Etymology.** *Piceus* from the Latin, blackish-brown, tar-coloured.

**Comparative notes.** *Paraliparis piceus* is in group IIIa. It is distinguished by its leaf-like, deep and compressed body and head, dorsally rounded opercular flap, blunt vertical snout, long upper pectoral lobe, radials 3+0 with R1 dorsally notched, uniform dark tar-colour, absence of rudimentary rays and costal keel, and short nephrohaemal canal. It is most similar to *P. lasti* but differs in tooth size (small *v.* large), terminal mouth (*v.* subterminal), Vert. 66 (*v.* 70), D 59 (*v.* 63), oral cleft reaching anterior margin of eye (*v.* centre of eye), having one fenestra (*v.* absent), deeper body (maximum 119 *v.* 107 HL, bdA 108 *v.* 91), and colour (dark blackish *v.* light brown with distinct reddish tint).

***Paraliparis plagiostomus* n.sp.**

Fig. 43

**Material examined.** HOLOTYPE CSIRO T488-02, ♂, 148 mm TL, 137 mm SL. FV *Petuna Endeavour*, stn. PE 6/8, 42°19.5'S 144°42'E, W coast of Tasmania, W of Cape Sorell, 993–987 m, 9 July 1983; radiograph 680 B; pectoral girdle 782.

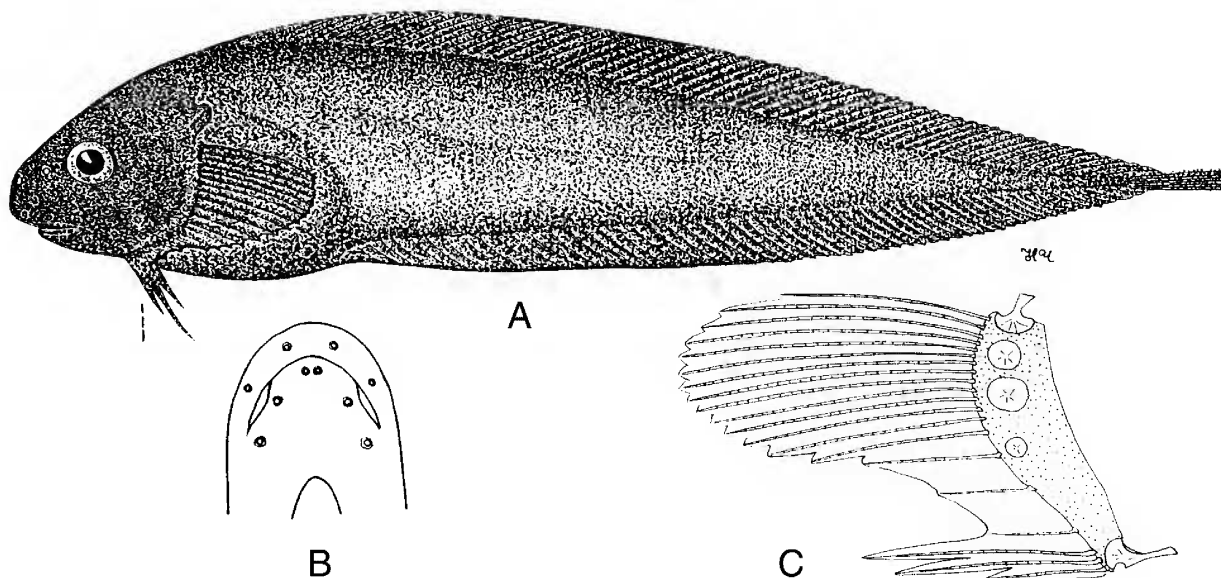
**Diagnosis.** Vert. 65, D 59, C 8. Radials 3, round. Jaws long, mouth inferior, teeth tiny, tooth plates appear smooth. Pores with distinctly contoured rims. Chin pores one diameter apart. Snout slanted, protruding, subrostral fold deep and entirely covering upper lip. Interorbital narrow. P 20 (15+2+3), upper ray horizontal with upper part of eye. Upper pectoral lobe short, 63% HL, lower lobe short. Gill opening equal to eye, dorsolaterally located, completely above horizontal through upper margin of eye. HL 18.7% SL, mandible-anus short, 10.9% SL. Uniformly brownish-

black, mouth and tooth plates dark grey, tongue black-dotted, gill arches dark grey, peritoneum black.

**Further description.** Counts: D 59, A 54, P 20, C 8 (4/4), Vert. 65 (11+54), radials 3 (3+0), pc 5, gr 8, pores 2-6-7-1. Ratios: HL 18.7, its width 10.9 (57.8), and depth 16.4 (88), bd 19.2 (103), bdA 17.2 (91), preD 21.0, preA 30.1, ma 10.9, aAf 19.1, UPL 11.7 (63), LPL 8.8 (75% UPL), NL c. 22% UPL, E 4.2 (22.7), gs 3.9 (20.7), sn 6.6 (35.5), io 7.7 (30.1), po 9.9 (53.1), so 2.9 (15.6), uj 10.2 (54.7), lj 8.9 (47.7).

Head small, 5.4 in SL, deep at occiput, dorsal contour sloping rapidly to snout tip; very compressed, its width slightly more than its length. Snout deep, rounded, large, 1.6 eye; greatly protruding beyond upper jaw, gelatinous. Nostril short, tube-like, with stout rim; horizontal with lower half of eye. Subrostral fold deep, entirely covering upper lip. Eye 4.4 in head, upper contour not touching dorsal profile. Interorbital narrow, 1.8 eye; suborbital 0.7 eye. Mouth inferior, its cleft reaching to below anterior margin of pupil. Upper and lower jaws large. Lower jaw subterminal (shorter than upper jaw, but not included); in ventral view, lower surface of snout and pores of upper jaw visible. Chin widely rounded, gelatinous. Teeth simple, tiny; tooth plates look smooth, in 25–27 regular rows, anteriorly of 7–9 teeth each. Diastema absent in upper jaw, narrow in lower jaw. Circumoral pores distinctly contoured, not in pits but on surface; chin pore interspace equalling their diameter, in a very shallow depression but not in a pit, anterior skin fold absent. Gill opening 0.9 eye diameter, vertical, dorsally located; its lower end horizontal with upper margin of eye. Opercular flap small, ear-shaped, with notched upper rim, its tip above a horizontal through upper margin of eye by distance equal to eye diameter.

Uppermost pectoral ray about on horizontal through upper margin of eye. Pectoral fin deeply notched, 20 (15+2+3), rudimentary rays absent. Upper lobe quite short,



**Figure 43.** *Paraliparis plagiosomus* n.sp. A, holotype, CSIRO T488-02, ♂, 148 mm TL, 137 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 782, cleared and stained right pectoral girdle.

not reaching anal-fin origin; of 3 thick rays. Skin of proximal surface of upper lobe attached at ray bases, about half way to tips of notch rays, and  $\frac{1}{5}$  of lower lobe ray lengths. Cartilaginous basal lamina of pectoral girdle with 3 (3+0) round radials, all in upper half of lamina; the lowermost small. Fenestrae in cartilaginous basal lamina absent. Helve of coracoid long and thin.

Body not deep but humpbacked, greatest depth at first dorsal rays, about equal to HL; dorsal contour sloping anteriorly and more gently posteriorly from this point, ventral profile straight. Horizontal midline anteriorly touching upper margin of eye. Predorsal length short. Parapophyses of vertebra 11 short, haemal spine absent. Interneural of first dorsal ray between neural spines 6 and 7, two free interneurals present anteriorly. Epineural ribs on vertebrae 2–10, anterior 7 quite stout and short, length about equal to 2.5 vertebrae. Epipleural ribs well developed on vertebrae 3–16, and as small but distinct commas on vertebrae 17–23; anterior 6–8 ribs quite stout, length up to 3 vertebrae. Lateral keel-like ridges at sides of body above pectoral fin present, not well developed. Vertical fins overlap caudal  $\frac{1}{3}$ . Anus below first third of postorbital space; mandible-anus distance short. Skin quite dense, opaque, prickles absent. Subcutaneous gelatinous tissue well developed, especially on lower surface of head and pectoral fins. Pyloric caeca similar to one another.

**Colour.** Head and body uniformly dark, brownish-black; lips, inner surface of subrostral fold, and chin black, anal area and urogenital papilla black. Mouth black, and tooth plates dark grey, tongue black-dotted, branchial cavity black and gill arches dark grey. Peritoneum black, pyloric caeca and stomach pale.

**Distribution.** West coast of Tasmania, around 990 m.

**Etymology.** The specific epithet, *plagiosomus* is from the Greek *plagios* “placed on lower surface of head” and *stoma* mouth.

**Comparative notes.** The new species is in group II. It differs from all other described *Paraliparis*, with the exception of *P. badius*, in having an inferior mouth and the gill opening entirely above eye level. See description of *P. badius* for comparison.

#### *Paraliparis retrodorsalis* n.sp.

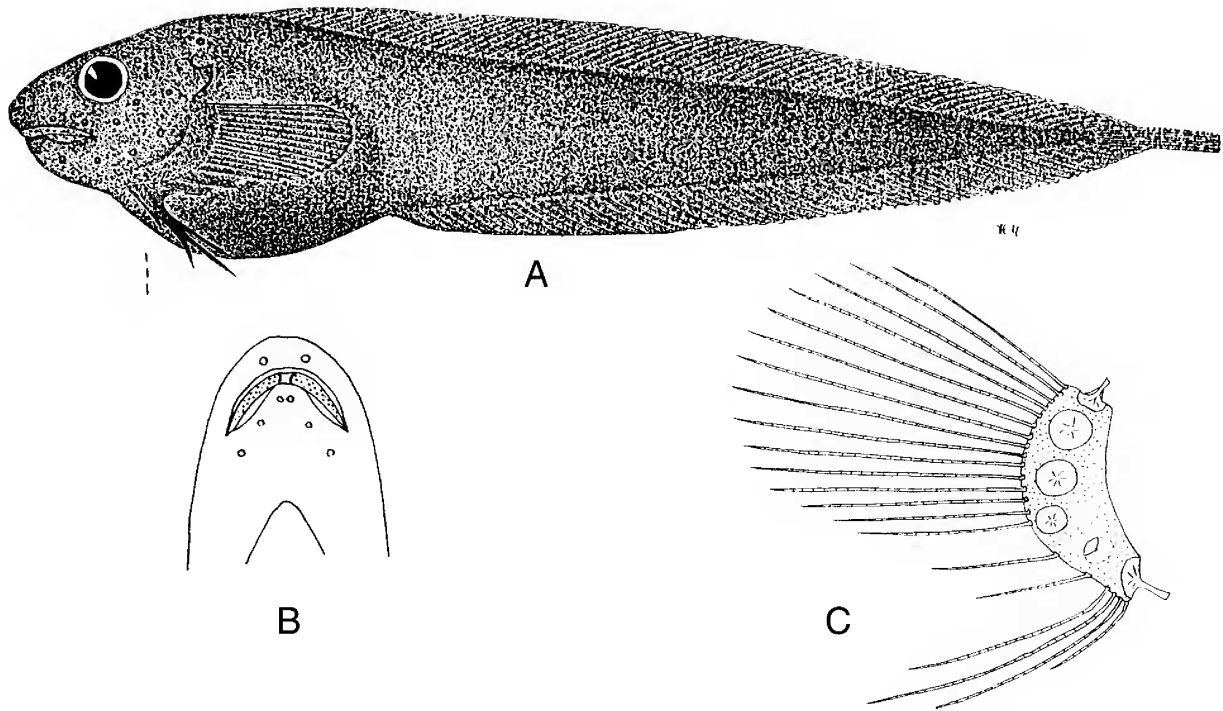
Fig. 44

**Material examined.** HOLOTYPE CSIRO H1935-01, ♀, 159 mm TL, 145 mm SL. FRV *Soela*, stn. So 1/89/56, 37°34.53'S 138°57.00'E, South Australia, W of Cape Martin, 1205–1175 m, 1 Feb. 1989; radiograph 682 E-1; pectoral girdle 736.

**Diagnosis.** Vert. 68, D 62, C 8, radials 4 (3+1? see below), round. Body not hump-backed. Mouth horizontal, subterminal, lower jaw included; chin pore interspace equal to pore diameter, not in a pit, without skin fold anteriorly. P 21 (15+2+4), rudimentary notch rays absent. Interneural of first dorsal ray between neural spines 7 and 8. Body and peritoneum black, mouth black, tongue black-dotted, tooth plates dark.

**Further description.** Counts: D 62, A 56, P 21, C 8 (4/4), Vert. 68 (12+56), radials 4 (3+1?), pc 5, gr 7, pores 2-6-7-1. Ratios: HL 18.1, its width 18.3 (57), and depth 16.7 (92), bd c. 19.9 (110), bdA 14.8 (82), preD 28.3, preA 36.6, ma 13.1, aAf 25.9, UPL 12.4 (69), LPL 11.0 (42% HL, 89% UPL), NL 4.1 (33% UPL), E 4.2 (23.3), gs 3.4 (19.1), sn 6.3 (34.4), po 9.0 (50), io 6.9 (38.2), so 2.8 (15.3), uj 9.0 (49.6), lj 8.3 (45.8), pc 4.5.

Head small, 5.5 in SL, dorsal contour gradually sloping anteriorly to low snout; compressed and deep, depth 1.6 its width. Snout projecting anteriorly, acutely angled, length 1.5 eye. Subrostral fold present, not entirely covering upper lip. Upper margin of eye almost touching dorsal profile of head, suborbital about  $\frac{2}{3}$  eye; pupil very large. Interorbital width 1.6 eye. Nostril small, with low rim, on horizontal



**Figure 44.** *Paraliparis retrodorsalis* n.sp. A, holotype, CSIRO H1935-01, ♀, 159 mm TL, 145 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 736, cleared and stained right pectoral girdle, rays reconstructed from left side.

with lower half of pupil. Mouth horizontal, subterminal; lower jaw included. In ventral view, upper tooth plates entirely visible below lip; lower jaw tapering anteriorly, chin rounded. Oral cleft reaching to below eye centre, lower jaw deep below end of cleft. Honeycomb tissue thick, well developed on chin. Teeth simple, quite large on upper jaw, smaller on lower jaw, about 24–25 regular rows of up to 8–10 teeth each anteriorly. Diastema of upper jaw distinctly wider than in lower jaw. Circumoral pores small, chin pores closely set, interspace equal to pore diameter, not in any depression, anterior skin fold absent, interspace pigmented. Gill opening small, 0.8 eye diameter, entirely above pectoral base; dorsal end slightly above horizontal through upper eye margin, lower end level with lower margin of pupil. Opercular flap small, triangular, with notched upper side, covering  $\frac{3}{4}$  of gill opening, tip level with upper margin of pupil.

Uppermost pectoral ray horizontal with lower margin of eye. P 15+2+4, bilobed, upper lobe not reaching anal-fin origin; notch rays not rudimentary, lower lobe short, its middle rays thin, elongated. Basal cartilaginous lamina short, wide in middle. Radials 3+1, round, third radial smaller, located at posterior margin of lamina; only part of the fourth radial present in cleared and stained preparation. Fenestrae absent. Scapula small, helve short with two thin lateral ribs, coracoid helve thin, not long.

Body elliptic, shallow, 5 in SL, deeper than HL, dorsal contour evenly sloping from deepest point (above dorsal origin) anteriorly and posteriorly. Horizontal midline close to oral cleft. Predorsal length long. Anterior dorsal rays reduced; interneural of first dorsal ray between neural spines 7 and 8; three free interneurals present anteriorly between spines 4 and 7. Length of haemal spine of last abdominal

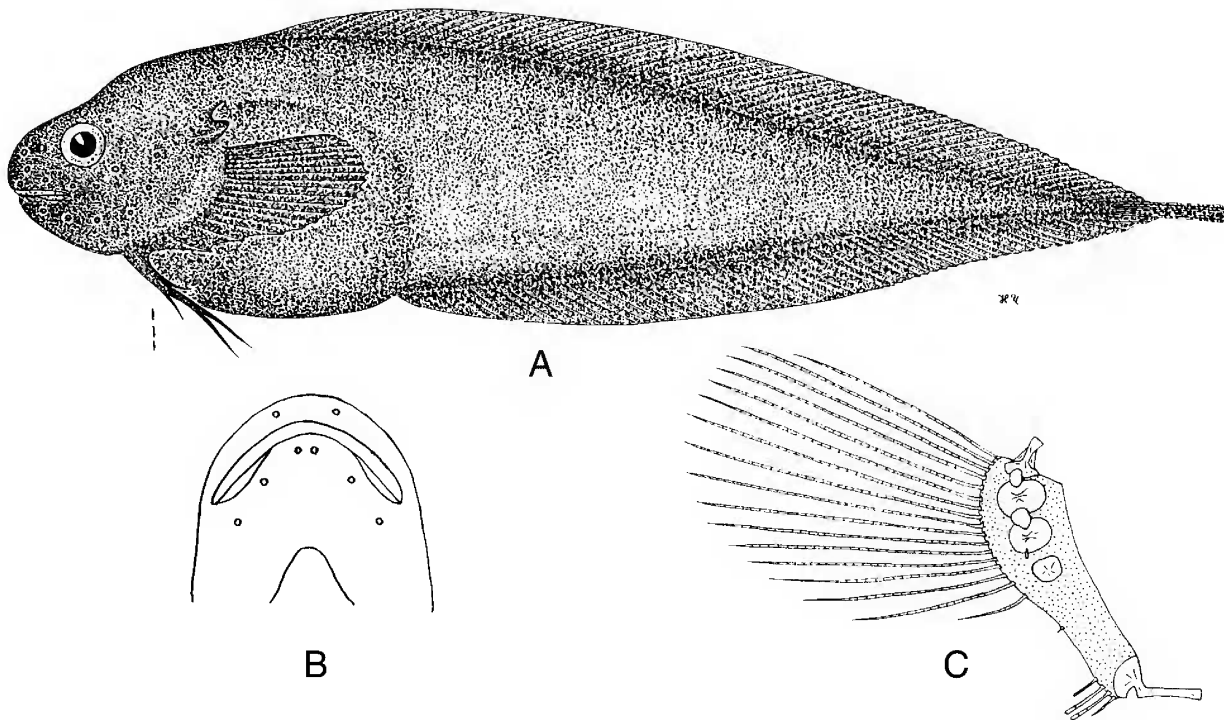
vertebra (12) about half that of next one. Costal ridges weak, but distinct. Epineural ribs present on vertebrae 3–18, epipleural ribs on vertebrae 3–15, thin, length of anterior not more than two vertebrae. Anus–anal-fin long. Vertical fins overlap caudal fin for about one-third. Skin quite thick, opaque, prickles absent. Subcutaneous gelatinous layer weakly developed. Pyloric caeca thick at their bases, of similar length. Diameter of ripe eggs c. 2.5 mm.

**Colour.** Head and body very dark, uniformly ink-black, subrostral fold as black as head, lips paler, dark grey. Mouth black, tongue black-dotted, tooth plates dark. Pores inside pale but not contrasted with head. Branchial cavity black, gill arches dark grey, peritoneum black, stomach and pyloric caeca pale.

**Distribution.** Off South Australia at 1205–1175 m.

**Etymology.** *Retrodorsalis* from the Latin *retro*—rear, and *dorsalis*—dorsal, referring to the relatively posterior position of the first dorsal-fin ray between vertebrae 7 and 8.

**Comparative notes.** *Paraliparis retrodorsalis* belongs to group IIIa and is distinguished by its very dark, ink-black, uniform colour, dark tooth plates, black mouth, more posterior dorsal-fin origin (first dorsal ray between neural spines 7 and 8), included lower jaw, upper jaw teeth somewhat larger than in lower jaw, diastema of upper jaw wider than in lower. It is most similar to *P. costatus* but differs in having weak ribs and lacking a costal keel (v. epineural and epipleural ribs strongly developed, keel distinct), D 62 (v. 66), first dorsal interneural between neural spines 7 and 8 (v. 5 and 6), 3 free interneurals present (v. one), C 4/4 (v. 1+3/3+1), and other characters.



**Figure 45.** *Paraliparis tasmaniensis* n.sp. A, holotype, CSIRO H2679-02, ♀, 213 mm TL, 201 mm SL. B, ventral view of mouth and upper jaw tooth plate. C, P 732, cleared and stained right pectoral girdle.

*Paraliparis tasmaniensis* n.sp.

Fig. 45

**Material examined.** HOLOTYPE CSIRO H2679-02, ♀, 213 mm TL, 201 mm SL. FRV *Soela*, stn. So 2/89/32, 40°26.64'S 143°18.36'E, NW Tasmania, SW of King Island, 1000–1100 m, 6 Mar. 1989; radiograph 684 F; pectoral girdle 732.

**Diagnosis.** Vert. 67, D 59, C 8, radials 3, upper two notched. Pectoral-fin upper lobe of 17 rays, widely separated from lower lobe of 4 rays by a wide notch with 1 rudimentary ray. Mouth horizontal, subterminal, teeth very small. Chin pores two, pit and anterior skin fold absent. Body deep, 125% HL, depth bdA 113. Eye small, 18.8% HL; gill opening equal to eye, reaching ventrally to horizontal through eye centre. Body deep, hump-backed, bdA 113% SL. HL 20% SL, preA 37% SL. Colour black, peritoneum black, mouth and tongue dark grey, tooth plates pale.

**Further description.** Counts: D 59, A 55, P 17+1r+4, C 8 (4/4), Vert. 67 (11+56), radials 3 (3+0), pc 7, gr 8, pores 2-6-7-1. Ratios: HL 19.9, its width 10.9 (55) and depth 17.4 (88), bd 24.9 (125), bdA 22.4 (113), preD 24.9, preA 36.8, ma 13.9, aAf c. 22.9, UPL 13.2 (66), LPL unknown, E 3.7 (18.8), gs 4.0 (20), sn 7.0 (35), po 10.6 (53.5), io 8.2 (41.3), so 3.6 (18.0), uj 8.5 (42.5), lj 8.4 (42), pc 7.5.

Head not large, 5 in SL, deep at occiput, depressed above eye; not wide, depth 1.6 its width. Snout large, 1.9 eye, rounded, slightly protruding above upper jaw, most dorsal point horizontal with upper third of eye. Subrostral fold deep, covering upper lip almost entirely. Nostril not large, rim raised, on level with lower half of pupil. Eye small, 5.3 in HL, not entering dorsal profile of head. Suborbital

distance about equal to eye, postorbital length large. Mouth horizontal, subterminal, reaching to below anterior margin of pupil. Lower jaw subterminal, slightly shorter than upper; jaw deep below end of mouth cleft; honeycomb tissue thick. In ventral view, lower jaw tapers anteriorly, chin rounded; when upper lip displaced, upper tooth plate edges visible. Teeth very small, not prominent, tips blunt, arranged in 23–26 regular rows of up to 9–12 teeth each anteriorly. Diastema of upper jaw wide, of lower jaw narrower. Circumoral pores small, chin pores not in a pit or depression, anterior skin fold absent, interspace equals 1.5 pore diameters; interspace pigmented. Gill opening vertical, small, 1.1 eye; dorsal end above eye level, ventral end level with eye centre. Opercular flap covering about  $\frac{2}{3}$  of gill opening, small, triangular, upper margin notched; tip horizontal with upper margin of eye.

Uppermost pectoral ray level with eye centre. P 17+(1)+4, with upper lobe rays widely separated from lower lobe rays (lowest shortest) by a wide notch including a single ray, that one rudimentary, visible only by clearing and staining. Upper lobe not reaching anal-fin origin, lower lobe length unknown (broken). Skin on proximal surface of upper lobe attached at about  $\frac{1}{4}$  lobe length, unknown in notch. Lowermost pectoral ray below posterior margin of eye. Radials 3+0, upper two notched; R3 small, round. Two fenestrae present below scapula and first radial; a slit-like rudimentary fenestra present below 2nd radial. Scapula notched ventrally, helve short, with two stout lateral ribs. Coracoid notched ventrally, with very long, thin, shaft.

Body hump-backed, elliptic, deep, 4 in SL, deepest at dorsal-fin origin; depth at A origin also greater than HL. Dorsal profile significantly rounded ventrally, both anteriorly and posteriorly from point of greatest body depth. Horizontal midline of body touching lower margin of eye.



Interneural of first dorsal ray between vertebral spines 6 and 7; anteriorly, 3 free interneurals present between spines 3–6. Haemal spine of last abdominal vertebra about half as long as next. Epineural ribs on vertebra 2–15, epipleural ribs on 3–17; thin, not long, anteriormost not longer than 2.5 vertebrae. Costal keel thin, slightly prominent. Anus below middle of postocular space. Degree of caudal overlap by vertical fins unknown. Skin quite thick, prickles absent. Subcutaneous gelatinous tissue moderately developed. Pyloric caeca similar. Egg diameter (ripening) 1.7–2.0 mm.

**Colour.** Head, body, snout, chin, and subrostral fold uniformly black; upper lip dark grey. Mouth and tongue dark grey, tooth plates pale. Pores paler than head. Peritoneum black, stomach and pyloric caeca black; posterior of rectum near anus blackish. Branchial cavity black, gill arches dark grey.

**Distribution.** Off NW Tasmania at 1000–1100 m.

**Etymology.** The specific epithet is a reference to Tasmania—the place of capture.

**Comparative notes.** *Paraliparis tasmaniensis* is in group IIIa. It is distinguished by having a rudimentary notch ray (v. notch rays not rudimentary) and 2 pectoral girdle fenestrae (v. absent), a deep body, small eye, and short upper jaw. In addition, *P. tasmaniensis* differs from *P. retrodorsalis* in being hump-backed (v. not hump-backed), radials 3+0, upper two notched (v. 3+1, unnotched), two fenestrae in pectoral girdle present (v. absent). It differs from *P. impariporus* in its entirely black colour, in having two chin pores (v. one pore), eye 19 (v. 26% HL); pectoral radials 3+0 (v. 4), two large fenestrae in cartilaginous basal lamina (v. two rudimentary), and a wide pectoral notch with one rudimentary ray (v. 2–3 normal notch rays).

### *Paraliparis* sp. 1

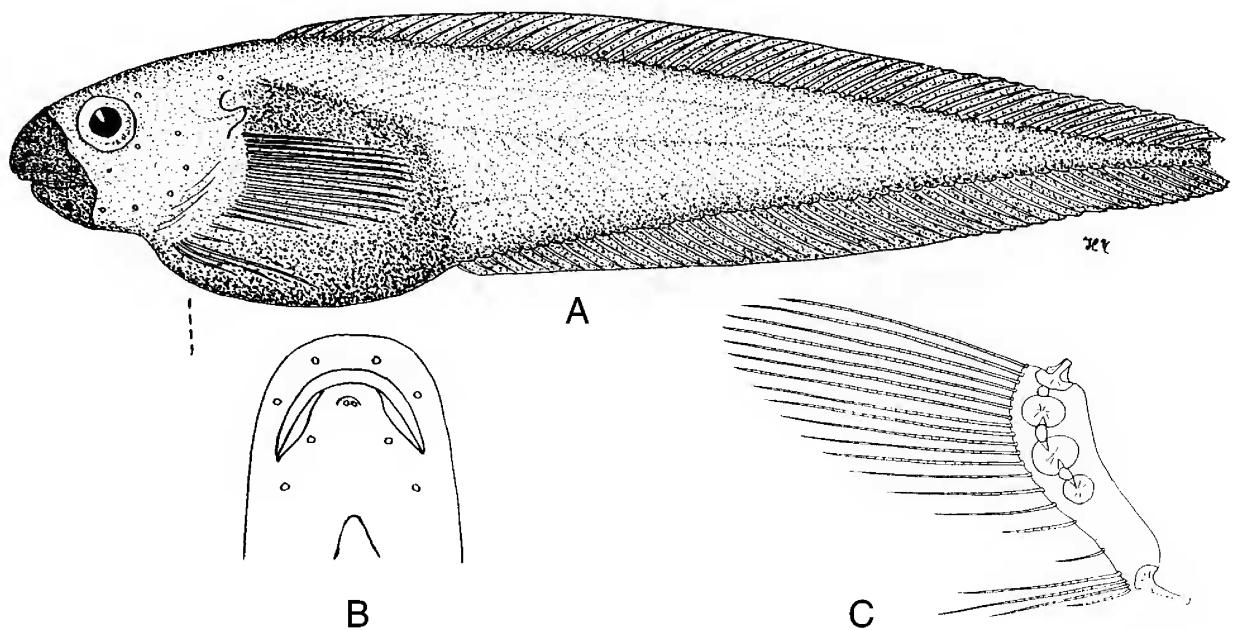
Fig. 46

**Material examined.** CSIRO H549-05, ripe ♀, length c. 134+ mm SL (a few posteriormost vertebrae missing). FRV *Soela*, stn. So 3/86/58, 41°50.4'S 144°23.45'E, W coast of Tasmania, W of Trial Harbour, 1328–1288 m, 25 May 1986; radiograph 680E; pectoral girdle 799.

**Diagnosis.** Vert. 56+, D —, C —, radials 3, all notched. Mouth subterminal, lower jaw included. Teeth simple, small. Subrostral fold absent. Chin pores in a small pit, interspace unpigmented, equal to their diameter. Ventral end of gill opening and dorsal pectoral-fin ray level with lower margin of pupil. Body straight-backed, ventral contour much more curved. Costal ridges slightly developed. P 19–21, rudimentary rays absent. Head less than 20% SL, predorsal 120% HL, preanal 193%. Body black, peritoneum black.

**Further description.** Counts: Vert. 10+46+, D —, A —, P 19–21, C —, radials 3+0, all notched; fenestrae three, pc 6, gr 8, pores 2-6-7-1. Ratios: HL less than 20% SL; in% HL: head width 58, and depth 77.5, bd 116, bdA 89, preD 120, preA 193, ma 79, aAf 114, UPL 69, LPL 46.5 HL (67% UPL), NL 12 (18% UPL), E 24.8, gs 19.4, sn 31.0, po 50.4, io 35.7, so 17.0, uj 42.6, lj 39.5, pc 31 (i.e., less than 6.3 SL).

Head less than 1/5 SL, compressed, depth 1.3 width. Dorsal contour straight, slanting anteroventrally. Snout rounded, projecting anterior to upper jaw, its highest point level with upper pupil margin, the most prominent point level with eye centre. Subrostral fold absent. Nostril level with lower margin of pupil. Eye almost entering dorsal contour of head. Suborbital distance short, less than 3/4 eye. Pupil 1/3 eye. Mouth subterminal, cleft reaching to anterior



**Figure 46.** *Paraliparis* sp. 1. A, CSIRO H549-05, ripe ♀, c. 134+ mm SL (a few posteriormost vertebrae missing). B, ventral view of mouth and upper jaw tooth plate. C, P 799, cleared and stained right pectoral girdle.

margin of pupil, jaws short. Lower jaw included. Lips not wide. Chin deep below end of mouth cleft; in lateral view tip slanted, honeycomb tissue well developed. Teeth simple, very small, slightly prominent, in c. 26 rows on upper jaw, 19 on lower, about 13 and 10 teeth per row anteriorly. Tooth plate on upper jaw wider than on lower. Diastema of upper jaw narrow, in lower jaw absent. Circumoral pores small; chin pores in a small pit, interspace unpigmented, equal to one pore diameter. Gill opening shorter than eye, ventral end level with lower margin of pupil. Opercular flap triangular, dorsally notched, sharp tip level with upper margin of pupil.

Upper pectoral ray level with lower margin of pupil, not reaching anal-fin origin; lower lobe short. Lowermost ray insertion below first third of postorbital space. Skin on fin missing. Radials 3+0, all notched. Fenestrae three, below scapula, below R1 and R2. Coracoid helve long, thin. Helve of scapula unusually strong. P 14+2+3 (L), 15+2+4 (R), rudimentary rays absent.

Body straight-backed, ventral contour much more curved than dorsal. Horizontal midline through lower margin of eye. Greatest depth at dorsal-fin origin. Abdominal and caudal vertebrae clearly distinguishable; last abdominal vertebra lacks haemal spine, that of first caudal vertebra very long. Parapophyses of abdominal vertebrae obviously not joined. First dorsal-fin ray short, its interneural between neural spines 4 and 5, 1 free interneural present anteriorly between neural spines 3 and 4. Costal ridges weakly developed. Epineural ribs on vertebrae 2–8, as long as 3 vertebrae; epipleural ribs on 2–14, thin, hardly visible. Anus almost below gill opening. Pyloric caeca slender. Ovarian eggs to 2 mm.

**Colour.** Body skinned. Snout and lower jaw ink-black. Upper lip as dark as head, lower lip and chin slightly paler. Pores not contrasting. Mouth and tongue dark grey. Branchial cavity black, gill arches grey. Peritoneum black, pyloric caeca and

stomach pale. Anal area and end of rectum black.

**Distribution.** West coast of Tasmania at 1328–1288 m.

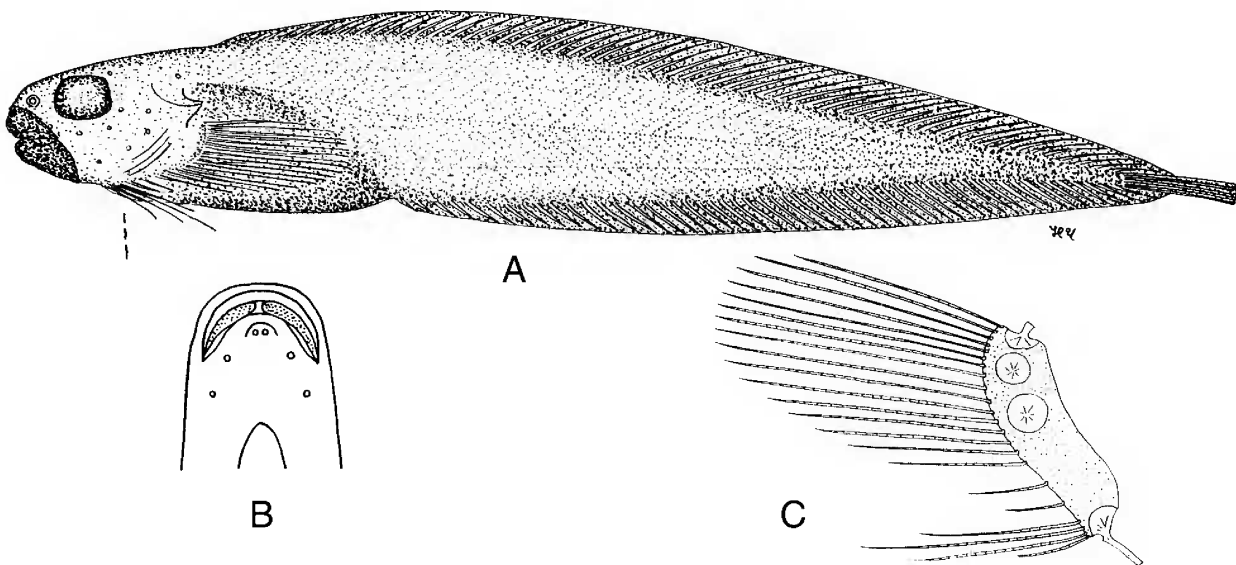
**Comparative notes.** A member of group IIIb, distinguished by its body shape, a straight back and greatly curved ventral contour, chin pore interspace unpigmented, lower jaw included, subrostral fold absent, anus almost below gill opening, and lower jaw below mouth cleft deep. Most similar to *P. infeliciter*, it differs in mouth cleft reaching to below pupil (v. to below anterior margin of eye), P 14/15+2+3/4 (v. P 17+2+3), fenestrae three (v. one), helve of coracoid thin (v. stout), helve of scapula not strong (v. strong), lower jaw included (v. subterminal), and anus almost below gill opening (v. first third of postorbital space).

### *Paraliparis* sp. 2

Fig. 47

**Material examined.** CSIRO H555-04, unripe ♂, 144 mm TL, 131 mm SL. FRV *Soela*, stn. So 3/86/38, 42°20.6'S 144°37.25'E, W coast of Tasmania, W of Cape Sorell, 1376–1404 m, 17 May 1986; radiograph 679-1; pectoral girdle 797.

**Diagnosis.** Vert. 67, D 61, C 8, radials 2, round. Mouth subterminal, short, lower jaw subterminal. Teeth simple, small. Subrostral fold absent. Chin pores in a small pit, interspace pigmented equal to their diameter. Ventral end of gill opening and dorsal pectoral ray level with lower margin of orbit, gill opening reaching 2nd pectoral ray. Anterior 3 dorsal rays short. Body low, shape elliptic, not humpbacked. Costal ridges present. P 16+2+4, rudimentary rays absent. Head small, 17.7% SL, predorsal length short, 18.5% SL, preanal 34%. Head black, peritoneum black with pale background.



**Figure 47.** *Paraliparis* sp. 2. A, CSIRO H555-04, unripe ♂, 144 mm TL, 131 mm SL. Eye missing. B, ventral view of mouth and upper jaw tooth plate. C, P 797, cleared and stained right pectoral girdle.

**Further description.** Counts: D 61, A 54, P 22, C 8 (1+4/4), Vert. 67 (11+56), radials 2+0+0, round; fenestrae absent, pc 4, gr 7, pores 2-6-7-1. Ratios: HL 17.7, its width 9.4 (53), and depth 12.8 (72.4), bd 15.1 (85), bdA 13.6 (77), preD 18.5, preA 34.0, ma c. 12.2, aAf c. 22.1, UPL 13.0 (73.3), LPL 10.7 (60.3% HL, 82% UPL), NL 3.1 (23% UPL), E —, orbit 4.7 (26.7), gs c. 3.7 (20.7), sn\* 5.3 (30.2), po\* 8.5 (48.3), io\* 6.3 (35.3), uj 7.9 (44.4), lj 7.5 (42.2), pc 5.7 (\* measured from margin of orbit, eyeball missing).

Head very small, 5.6 in SL, compressed, depth 1.4 its width. Eyeball missing, orbit close to upper contour of head but suborbital distance very short, about half of orbit. Snout deep, rounded, slightly projecting anterior to upper jaw; its highest point close to level of upper margin of orbit, most prominent point slightly below. Subrostral fold obviously absent. Nostril slightly below level of eye centre. Mouth barely subterminal, its cleft short, reaching only to below anterior margin of orbit. Lower jaw subterminal, almost included. Teeth very small, simple, slightly prominent, in 16–17 rows, about 8 teeth anteriorly. Narrow diastema in upper jaw. Chin pores in a common small pit, interspace pigmented, equalling their diameter. Chin tip slanted in lateral view (not right-angled), deep below end of mouth cleft. Gill opening reaching 2nd pectoral ray, its ventral end level with lower margin of orbit. Opercular flap triangular, tip directed posteriorly, level with eye centre.

Upper pectoral ray level with lower margin of orbit. P 16+2+4, notch rays about ¼ UPL. Fin membrane missing. Base of lowest ray below posterior margin of orbit. Upper lobe not reaching anal-fin origin. Radials 2+0+0, round; fenestrae absent. Coracoid helve thin, long.

Body not humpbacked, low, of elliptical shape, dorsal and ventral contours similar. Maximum depth 6.6 in SL, deepest at anal-fin origin, contours sloping evenly anteriorly and posteriorly. Horizontal midline through centre of orbit. Predorsal length short. Two free anterior dorsal interneurals, the first between vertebrae 2 and 3; anterior 3 dorsal rays short. First dorsal ray above tip of opercular flap. Costal ridges not large, but distinct. Vertical fins overlapping about half of caudal. Anus below first third of postorbital space. Pyloric caeca of similar lengths, with sharp tips.

**Colour.** Body and head skinned, snout, lips, and chin black with pale background, skin thin and semitransparent. Tooth plates pale, mouth grey, tongue grey, dotted. Branchial cavity dark grey, gill arches grey. Peritoneum black with distinct pale background. Pyloric caeca and stomach pale.

**Distribution.** West coast of Tasmania, 1376–1404 m.

**Comparative notes.** This specimen is quite different from the other species of its group. It seems to be a new species, but because of its poor condition (skinned body, missing eye balls) we prefer not to name it but designate it as “sp. 2”. It should be described when better specimens become available. It is a member of group IIIb, distinguished by its low, elliptically-shaped shallow body, short predorsal length, peritoneum not ink-black but with a pale background, anterior three dorsal rays short, mouth cleft reaching only to below anterior of orbit, costal ridges present, gill opening reaching to 2nd pectoral ray, and radials 2+0+0, round.

## Incertae sedis

### *Paraliparis* sp. (cf. *copei* group)

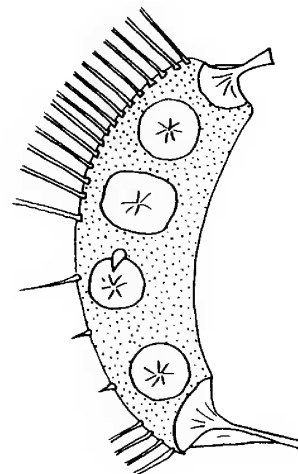
Fig. 48

These specimens are in such poor condition that we can provide only a partial description of them. They are clearly distinct from the other specimens examined for this paper, but so many characters are unknown that description awaits better material. Because of their condition and their similarities, we treat them together although we recognize that they are probably not the same species.

**Material examined.** AMS I22809-036, ripe ♂, c. 178 mm SL. FRV *Soela*, 18°40'S 116°42'E, Indian Ocean off Western Australia, 250 km NW of Port Hedland, 584–592 m, 4 Apr. 1982; radiograph ZISP 2054; pectoral girdle 738. AMS I22813-018, ripe ♂, 154+ mm TL. FRV *Soela*, 18°32'S 116°50'E, Indian Ocean off Western Australia, 250 km NW of Port Hedland, 658–660 m, 6 Apr. 1982; radiograph ZISP 20253; pectoral girdle 737.

**Description.** The specimens are similar in having the head short, profile rounded; mouth subterminal, lower jaw included, tooth plates entirely visible in ventral view. Teeth small, stout canines, uniserial for posterior ⅔ of jaws, biserial for anterior third, similar in both jaws. Opercle horizontal, broadly curved, with tip pointing dorsally. Gill opening damaged. Pectoral fin damaged, upper lobe of at least 14 rays, lower lobe of at least 3 rays. Radials 3 or 4. Prominent costal keels present. Scapula stout, helve short, triangular; coracoid helve very long, with ventral strengthening blade. Body relatively deep but not humpbacked, elliptical. Pyloric caeca 3?, stout, digitate. The specimens differ significantly:

In I 22813-018, Vert. 63+ (=11+52+), epineural ribs on vertebrae 2–13, epipleural ribs on 2–15; anteriormost 8 of both series strong, long, sabre-like, up to 4 vertebrae in length. D insertion between vertebrae 4/5. Right girdle: 2+0+1, R1 ventrally notched, R2 dorsally and ventrally notched. Fenestrae between R1 and 2, one rudimentary fenestra below R2. Coracoid helve long, thin. Left girdle with 3+1 radials.



**Figure 48.** *Paraliparis* sp. (cf. *copei* group), AMS I22809-036, ♂, c. 178 mm SL. P 738, cleared and stained right pectoral girdle.

In I 22809-036, Vert. 42+ (=11+31+), epineural ribs on at least vertebrae 2–10, epipleural ribs on at least vertebrae 2–9. Radials 3+1, R1 and 2 unnotched, R3 notched dorsally. One foramen above R3. Rays partially missing. Two rudimentary rays in notch.

**Colour.** Body colour unknown, lips brownish. Orobranchial cavity and gill arches pale, brown-dotted. Peritoneum very dark brown or black, stomach and caeca pale.

**Distribution.** Indian Ocean off Western Australia at 584–660 m.

**Comparative notes.** These two specimens differ significantly in radial number and presence of notches. There is no question that in their dentition, the two differ greatly from all the other Australian species we have examined, which have teeth forming wide bands. In dentition these two are similar to the “*P. copei*–*P. rosaceus* group”, that includes the Pacific *P. attenuatus* Garman, 1899, *P. rosaceus* Gilbert, 1890, *P. grandiceps* Garman, 1899, *P. nassarum* Stein & Fitch, 1984, and *P. paucidens* Stein, 1978b; the Atlantic *P. copei* Goode & Bean, 1896 and *P. copei wilsoni* Richards, 1966; and the Antarctic *P. copei gibbericeps* Andriashev, 1982a and *P. c. kerguelensis* Andriashev, 1982b. All of these species look similar and have very narrow tooth bands generally suggesting a trend from biserial teeth to uniserial and finally to only a few scattered teeth.

## Discussion

Presence of a diverse liparid fauna in Australian waters is not surprising, given their occurrence on the Pacific coast of South America, at all benthic depths throughout Antarctic waters and islands, and off southern Africa. Although we might have assumed the presence of liparids in waters of South Australia, we were amazed to find so many species in such a small collection, suggesting that the family has more taxonomic and ecological diversity than previously thought.

Concerned that so many species appeared to exist in our material, we tried to reduce the number by finding characters supporting determination of conspecificity, but instead found clear distinctions. In our experience, these differences are trenchant. Therefore, we describe most of these specimens as representatives of new species. Furthermore, we expect that as exploration of Australian slope and abyssal depths continues, even more species will be found.

**Morphology and relationships to other liparids.** The centre of taxonomic and ecological diversity and numerical abundance of the family is in the North Pacific, where most genera, both primitive and advanced, occur. In particular, the primitive genera *Liparis* and *Careproctus* are very diverse in the Bering Sea, Sea of Okhotsk, and adjacent regions, where many monotypic genera are also present. Some of these species reach very large size (for liparids), up to 700 mm TL (*Liparis niger* Soldatov & Lindberg, 1930; Andriashev, unpublished). In contrast, in the Southern Hemisphere, *Liparis* is absent and the approximately 45 *Careproctus* species are not morphologically diverse. Southern *Careproctus* species have more advanced

character states than northern species, indicating their evolutionary distance from many North Pacific relatives, and all are medium-sized to very small. Furthermore, the endemic Southern Hemisphere genera (*Edentoliparis* Andriashev, *Eknomoliparis* Stein *et al.*, *Genioliparis* Andriashev & Neelov, *Notoliparis* Andriashev) are clearly derived, not primitive. Finally, the cottoids, the sister group of the cyclopteroids (that is, the cyclopterids and liparids), are also widely distributed and highly diverse in the North Pacific (Yabe, 1985). Our results strongly support the North Pacific as the centre of origin, centre of morphological diversity, and the location of the most primitive genera.

Southern Hemisphere liparids are characterized by radiation within genera rather than among genera (Andriashev, 1998). Thus, there are many endemic species but only a few endemic genera. In addition, the apomorphic character states of *Careproctus*, and the absence of *Liparis* from the Southern Hemisphere, strongly indicate that the liparid fauna of the Southern Ocean is young and secondary. The Australian *Paraliparis* clearly form a distinct species group quite different from the Antarctic species. Owing to their unusual morphological similarity we hypothesize that they form a “species flock” in the sense of Greenwood (1984: 18), “an aggregate of several species... if its members are endemic to the geographically circumscribed area under consideration and are each others’ closest living relatives” and Ribbink (1984: 24), “an assemblage of a disproportionately high number, relative to surrounding areas, of closely related species which apparently evolved rapidly within a narrowly circumscribed area to which all the member species are endemic.” We believe they typify Pianka’s (2000) statement that “Species-rich genera are both rare and extremely interesting because they imply that recent bouts of speciation and niche diversification have occurred, leading to adaptive radiation. Such events of rapid evolution promote species diversity”. Future analyses based on specimens not yet collected will provide the test of our hypothesis.

**Paraliparis.** Australian and Southern Ocean *Paraliparis* are morphologically distinct, although clearly members of the same genus. The combined range of intraspecific meristic variability across all 28 Australian species is small; it is similar to the range of interspecific variability within single species from the Southern Ocean. For example, the range in number of vertebrae in all Australian species is 7 (65–71); moreover, 21 species (77.7%) have 65–68 vertebrae (Table 3). In the 29 Southern Ocean species listed by Andriashev (1986), the range is 30: number of vertebrae varies from 51 (*P. trilobodon*) to 81 (*P. tetrapteryx*) (Andriashev, 1986: 156). In *P. thalassobathyalis* Andriashev, the range is 6 (Table 4). Variability in fin-ray number is similar: Australian species have D 58–64 (v. 45–73 in Southern Ocean species), A 52–57 (v. 41–66), P 19–24 (v. 15–31). Uniformity of the Australian *Paraliparis* in caudal-fin ray number is very high compared to the Antarctic species: 25 species have C 8, and only 2 have C 9 (v. 4–11 in the latter). Variability in pyloric caeca number is similar: 3–7 (v. 0–15).

**Table 3.** Interspecific variation: number of vertebrae in Australian *Paraliparis* species.

| vertebrae         | 65 | 66 | 67 | 68 | 69 | 70 | 71 | n  |
|-------------------|----|----|----|----|----|----|----|----|
| number of species | 6  | 7  | 4  | 4  | 2  | 3  | 1  | 27 |

**Table 4.** Intraspecific variation: number of vertebrae in *P. thalassobathyalis* from Meteor Sea Mount (from Andriashev, 1986).

| vertebrae           | 56 | 57 | 58 | 59 | 60 | 61 | 62 | n  |
|---------------------|----|----|----|----|----|----|----|----|
| number of specimens | 0  | 4  | 11 | 8  | 3  | 1  | 1  | 28 |

Some important morphometric characters vary little in Australian species. All have a short gill opening from 3.0–4.3% SL in length; in the majority, it is less than 4% SL. The range in Southern Ocean species is from pore-like (1–2% SL) in the *P. copei* group, to 15–16% SL in *P. antarcticus* and *P. meganchus* (Andriashev, 1986). All Australian species have closely-set chin pores: 29% have chin pores in one common pore or interspaced at a distance less than one pore diameter, and 61% have them separated by a distance equal to one pore diameter; in only 3 species is this distance equal to two pore diameters. In Southern Ocean species, the position of the chin pores is more variable: they are in one common pore, are more or less closely set, or are widely spaced so that distance  $pm_1$ – $pm_1$  equals or is larger than  $pm_1$ – $pm_2$ . In many Australian species the chin pores are not only closely set, but also placed in a more or less developed common pit, or have an anterior skin fold not found in Southern Ocean species. The snout is often deep, with widely spaced nasal pores ( $n_1$  and  $n_2$ ). Finally, most have a small mouth and small to exceptionally small teeth (21 species, or 75%).

**Pectoral girdle.** Almost half the Australian species have plesiomorphic pectoral girdle character states typical of *Liparis* (notched radials and different types of fenestra between radials, often associated with the notches), although they are not as well developed and their occurrence is more variable than in *Liparis*. In contrast, only one “Antarctic” *Paraliparis* species (*Paraliparis stehmanni* Andriashev, 1986) has notched radials and interradial fenestrae. In the Australian species, these features are different with respect to their quantity, shape, size, location, and position. Because almost all species are represented by single specimens, it is impossible to draw conclusions regarding intraspecific variability.

It is also worth noting the occurrence in *P. coracinus* of the horseshoe-shaped R3 forming part of the margin of the pectoral girdle. As stated in the comparative notes for that species, there are now three species known with one or more such radials. Despite this similarity, it is clear that the new species is not closely related to either of the other two species, which are Antarctic and very different in many other respects.

Occurrence of all three radials in the upper half of the basal cartilaginous lamina is unusual in *Paraliparis*. It occurs in 12 Australian species (*ater*, *auriculatus*, *australiensis*, *avellaneus*, *badius*, *gomonii*, *infeliciter*, *lasti*, *piceus*, *plagiostomus*, *tasmaniensis*, sp. 1). Previously known only from the Chilean *P. merodontus* Stein *et al.*, 1991, occurrence of this character state in many more species suggests it is another variant of radial position that may represent a distinct evolutionary branch. This character state, the horseshoe-shaped R3, and other characters support Andriashev’s (1986: 187) hypothesis that “the complex mosaic of characters suggests a probable invasion by liparidids [sic] into the southern hemisphere repeatedly and by species at different levels of evolutionary development.” In other words, by species from different clades.

**Epineural/epipleural ribs and costal ridge.** The absence of pleural ribs is a characteristic morphological feature of the genus *Paraliparis* (Kido, 1988), in which the usual character state is short, thin, curved epineural and epipleural ribs on abdominal and anterior caudal vertebrae. However, in some Australian species, we found greatly developed epineural and epipleural ribs which, at their greatest development, produce a distinct external keel-like costal ridge above the abdominal cavity on each side of the fish. This is a previously undescribed character unique to these species among liparids.

Epineural ribs are present from the 2nd (less commonly 3rd) to 6–19th vertebrae in all Australian species. Anteriorly, they start at the vertebral neural arches, and posteriorly are at the parapophyses and caudally, at the haemal arches. Epipleural ribs occur anteriorly on vertebrae 2–3, occasionally on 4 or 5 and then to the 11–25th vertebrae, depending upon species. Anteriorly, they are located on the vertebral body and posteriorly on the parapophyses and haemal arches. They probably occur in all species, although we could not see them clearly in radiographs of *P. infeliciter*, *labiatus*, and *piceus*.

Usually both epineural and epipleural ribs are slender and short, no longer than 1.5–2 vertebrae, occasionally as long as 3 vertebrae. However, in three species (*P. costatus*, *P. dewitti*, and *P. sp.* (cf. *copei* group) from the Indian Ocean) the anterior 7–9 ribs (both rows) are stout and elongated, reaching 4–5 vertebrae in length (Fig. 11). In these species, the ribs form the support for the costal ridge, which may be present to some extent in other species (*P. lasti*, *Paraliparis* sp. 2, for instance), but is much less well developed. This seems to be an apomorphic character unique to these species.

**Chin pores.** The Australian liparids demonstrate all variations of chin pore character states, from fused (i.e., a single pore), paired and touching, with an interspace from much less than one pore diameter to two pore diameters, in a pit, not in a pit, and finally, with a distinct skin fold anterior to the pore pair. We have found little intraspecific variability in this character in other species, and have therefore used it consistently to distinguish the new species where possible. We do not understand the functional significance of these interspecific variations, although we assume that, because these pores are so close to the mouth, they are related to feeding behaviour or food habits. In studies of food-finding by other Antarctic fishes (mainly Nototheniidae) Janssen (1996) considered the chin pores the most important cephalic pores.

**Colour.** One of the significant differences between the Australian and Antarctic species is colour. The body and body cavities of the Australian species are characteristically darkly pigmented (including black, brownish-black, dark brown, and brown). Twenty-three species (82%) are very dark; only 5 (18%) are paler (nut brown, light brown). In contrast, Southern Ocean species are mainly pale after fixation (61%), and in life are pale or rosy. Only a few are lilac-rose; this coloration persists after fixation, becoming paler. One species, *P. cerasinus*, is quite dark grey after preservation, although cherry-red in life. Brown or black species are very rare; *P. trunovi* and *P. leucoglossus* are the only Southern Ocean species similar in colour to those of Australia. We suggest that these colour differences reflect absence of close relationships between the two groups.

**Summary.** Australian *Paraliparis* species are much more similar to each other than are co-occurring *Paraliparis* species in other geographic areas such as Antarctica (Andriashev, 1986) or the northeastern Pacific (Stein, 1978b). Nevertheless, the Australian species differ distinctly (although often subtly) from each other in many ways: general body, snout, and opercular flap shape, degree of development of subrostral fold (from deep to absent), presence or absence of rudimentary rays in the pectoral-fin notch, pectoral-fin mobility (the degree to which corresponding pectoral-fin rays are free of gelatinous tissue is highly variable between species), and state of chin pores (at the surface, in a pit, protected by an anterior skin fold). In some species the chin has a well-developed layer of honeycomb tissue, or the chin profile is not slanted as usual but is distinctly right-angled. The skin in some species is quite thick and dense, but in others it is thin and semitransparent, and the pale musculature seen through it influences the general body colour. We suggest this is a monophyletic group that evolved recently in the conditions of oceanic isolation that resulted in the high endemism of shallow-water Australian marine taxa (Wilson & Allen, 1987), and hypothesize that these distinct but small morphological differences (relative to those evident among *Paraliparis* in other regions) represent recency of evolution, i.e., Australian *Paraliparis* are so similar because they diverged recently. That all 29 species from southeastern Australia occur at similar depths (987–1404 m, 20 species at 987–1225 m) also supports this hypothesis. Although it is difficult to generalize on the basis of so few specimens of each species, their apparent sympatry is striking: one trawl (1000–992 m) caught 5 different species (*P. ater*, *P. auriculatus*, *P. brunneus*, *P. delphis*, and *P. labiatus*). In our experience this is unusual.

***Pseudnos*.** In comparison to other species of *Pseudnos* from both the northern and southern hemispheres, the Australian species have a large number of vertebrae (56–58 v. 39–47), differently arranged pectoral radials (2+0+1 v. 1+1+1, equally spaced), and notched radials with one or two interradial fenestrae (v. round, unnotched, fenestrae absent). Because these character states are plesiomorphic for the genus, and are similar to those found in other liparid genera, we suggest that these interpretations support the hypothesis of Andriashev (1992, 1993) regarding a Southern Ocean origin for the genus. However, there are a number of *Pseudnos* species from elsewhere in the Pacific that are undescribed. There seem to be two or three from off Mexico, one from New Zealand, and possibly one or two more from the central South Pacific (DLS, unpublished). Analysis of evolution in *Pseudnos* awaits description of these species.

**Distribution.** Contrary to the situation in the Northern Hemisphere, in the Southern Hemisphere shallow-water liparids are generally absent (exceptions being the isolated Falklands, South Georgia, South Shetland Is and the southern tip of South America) and those present have deep-water ancestors (Andriashev, 1965). Deep-water species are common in both hemispheres (Andriashev, 1998; Burke, 1930; Stein, 1978b; and others). Given the rich liparid fauna of the Southern Ocean (Andriashev, 1998; Andriashev & Stein, 1998; Stein & Andriashev, 1990), it is not surprising that Australia also has a liparid fauna. Both Antarctica and Australia are isolated “continental islands” with significant

endemic shallow water faunas. In Antarctica, the notothenioids, dominant in shallower waters, are replaced at greater depths by the secondary deep-sea fishes, especially liparids and zoarcids (Andriashev & Stein, 1998), suggesting that the latter arrived after the notothenioids were already dominant. Otherwise we would expect to find liparids abundant at shallower depths also. There is not an obvious parallel in Australian temperate waters; data are not yet available to provide even a hazy picture of the distribution of Australian fishes below mid-slope depths.

Why are there no shallower liparids around Australia in cool temperate regions such as Tasmania, considering that some Southern Ocean islands (e.g., South Georgia), have shallow species evolved from deeper water ones (Andriashev, 1965)? The temperatures around Tasmania (surface: 10.5–18.5°, Harris *et al.*, 1987) are similar to those in the North Pacific off Southern California (surface: 12.5–20°, Anon., 2000), where post-larval liparids occur in the plankton. Perhaps the answer is that the deeper water genera do not have the same temperature tolerance as the shallow water *Liparis* of the North Pacific and North Atlantic Oceans.

Wherever deep-water liparids occur, their species diversity is high, probably owing to their life history characteristics. They have large benthic eggs and probably have direct development (Kido & Kitagawa, 1986; Stein, 1980). In addition, a number of species in North and South America are known reproductive commensals, laying eggs in the carapaces of crabs and in other invertebrates (Able & Musick, 1976; Andriashev & Prirodina, 1990; Balbontin *et al.*, 1979; Peden & Corbett, 1973; and others). For these reasons, they are less likely to disperse or be dispersed, and are more likely to be affected by topographic barriers such as shallow water or deep submarine canyons. Thus, the liparids include many genera that are closely tied to the bottom, whose members are relatively unaffected by water movement, and in which the species are easily isolated, leading to “local” evolution and subsequent existence of endemic species groups. Such a pattern is not unlike that occurring in some terrestrial groups of isolated (but closely related) taxa whose ranges are restricted by and to topographic features such as mountain tops or canyons.

The odd pelagic genus *Pseudnos* is known from South Africa and the North Atlantic, and specimens of undescribed species are known from off Southern California, Mexico, and New Zealand. It seems likely that representatives of the genus occur worldwide at mesopelagic depths, but at low population densities.

Recent exploration of deep-water areas in search of commercially exploitable fish (Koslow *et al.*, 1994; May & Blaber, 1989; Williams *et al.*, 1996) has led to a great expansion of knowledge about fishes of the mid- and upper Australian continental slope, for example, chondrichthyans (Last & Stevens, 1994). Despite these collections, not enough is known yet about the deep-water fauna to support its biogeographic analysis. Koslow *et al.* (1994) analyzed the mid-slope demersal fish community of southeastern Australia and investigated its similarity to the mid-slope communities of the eastern and western North Pacific and North Atlantic and off New Zealand. At the generic and family level, there was “substantial overlap” with North Atlantic slope faunas, but little with that of the North Pacific. They hypothesized this was related to the distribution of

the Antarctic Intermediate Water Mass, which does not penetrate far into the Pacific, but which has been detected as far as 20°N latitude in the North Atlantic, providing a corridor for dispersal. They concluded that, therefore, the Australian deep water fauna has a closer evolutionary relationship with the North Atlantic fauna, supporting Andriashev's (1991) hypothesis of a southern transoceanic liparid dispersal pathway. Liparids apparently dispersed from the Antarctic into the South, and then North, Atlantic Oceans after the opening of the Drake Passage 20–22 MYBP, possibly using midocean ridges (Andriashev, 1977). It is important to note that the Antarctic species of the Nototheniidae (with one or two exceptions), Artedidraconidae, Channichthyidae, and others did not disperse northwards. Amaoka *et al.* (1990) surveyed fishes off New Zealand and reached the opposite conclusion to Koslow *et al.* (1994), stating that 113 genera (of 265) and 40 species (of 267) were common to New Zealand and Japan. These results may not be directly comparable to those of Koslow *et al.* (1994), however, because Amaoka *et al.* (1990) included pelagic and benthic species from a wide variety of depths, whereas Koslow *et al.* (1994) included only mid-slope demersal species.

Despite the paucity of knowledge regarding development and distribution of the Australian deep water fish fauna, analysis of the shallow water fishes is suggestive. There is a notably high degree of endemism in southern Australian shallow water fishes and invertebrates without a pelagic early life history (Wilson & Allen, 1987). Pleistocene sea level fluctuated more than 200 m, at times creating land barriers to dispersal, and resulting in species pairs on the western and eastern sides of Tasmania. Some shallow water fish families underwent great radiation, apparently because “the temperate environment would appear to offer more opportunity for niche specialization because of lowered competition” (Wilson & Allen, 1987) compared to the tropics where species diversity, and thus competition, is much higher. “The four [fish] families exhibiting the most speciation... are characterized by reproductive modes that tend to discourage extensive dispersal” and “there are several southern Australian temperate species of diverse groups which also occur in similar latitudes in the northern Pacific or which have close relatives there”. The presence of at least 16 families that also occur in the North Pacific is presumably associated with narrowing of the tropical zone and reduction of the barrier it presented (Wilson & Allen, 1987). All of the preceding factors may have played roles in diversification of the liparids in Australian waters.

**Conclusions.** A few decades ago, we would have confidently stated that only a few liparids exist in the Southern Hemisphere. Now, however, it is clear that there are probably at least as many species, but not as many genera (about 120 species known in 7 genera *v.* more than 130 in about 20 genera) in the Southern Hemisphere as in the Northern, and that despite the work of the last two decades, many more remain to be discovered and described, not only from Australia, New Zealand, and Chile, but also from Antarctica.

Although the possible derivation of some Atlantic liparids from South Pacific or Southern Ocean ones is becoming clearer, the origins of Australian liparids are unknown. They are not closely related to Antarctic liparids and are unlikely

to be derived from North Atlantic taxa (Andriashev, 1998). It is possible that Australian species are derived from those on the west coast of Chile, which in turn seem likely to be derived from North Pacific species.

In 1970, Giles Mead wrote in “The History of South Pacific Fishes”, that the Order Scorpaeniformes “are potentially a most significant group for historical analysis”, that the history of the Suborder Cottoidei (which includes the liparids) “will, when fully understood, form a zoogeographical contribution of great importance”, and that the fish fauna of cold-temperate Chile will be crucial in this analysis. He further included the cold-temperate North Pacific and the cottoids as one of the four sources of the temperate South Pacific fish fauna. It is clear that when an analysis of the historical biogeography of Southern Hemisphere liparids is accomplished, it will provide significant advances in knowledge of the relationships among the secondary deep-water fish faunas of the South Pacific and how they evolved.

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